

# Some Morphological, Physical, Chemical, and Mineralogical Properties of Seven Southern Great Plains Soils

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# SOME MORPHOLOGICAL, PHYSICAL, CHEMICAL, AND MINERALOGICAL PROPERTIES OF SEVEN SOUTHERN GREAT PLAINS SOILS[1]

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## INTRODUCTION

The purpose of this bulletin is to present morphological, physical, chemical, and mineralogical characteristics of seven Southern Great Plains soils. The data should prove useful to all agriculturists interested in interpretation of soil behavior.

The data are the result of a project to characterize soils where dense, hard layers form immediately below depth of plowing. Immediate objects of the research project were:

1. To compare soil properties within these hard or dense layers with those of layers immediately above or below.
2. To compare properties of soils containing these dense or hard layers with those of nearby virgin sites of the same soil type.
3. To characterize physical, chemical, and mineralogical properties of soils subject to formation of these dense or hard layers in order to determine the more susceptible soils.

This project, initiated in 1957, was terminated in 1960 when it became apparent, through analyzing the data and the results of other experiments (10, 21),[3] that plant rooting habits on the selected soils are probably not determined by the measured variables but by excess soil strength.

## EXPERIMENTAL METHODS

Sites for paired native grass and cultivated soil profiles were selected with the aid of Soil Conservation Service soil scientists. The locations of these sites are shown in figure 1. At each site, a pit was

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[1] Contribution from Soil and Water Conservation Research Division, Agricultural Research Service, USDA, with the cooperation of Soil Conservation Service, USDA, and the Texas Agricultural Experiment Station.

[2] Soil Scientists, USDA, located respectively at Bushland, Tex., Fort Collins, Colo., Bushland, Tex., Bushland, Tex., and Bushland, Tex., and Field Specialist, Soils, Soil Conservation Service, USDA, located at Lubbock, Tex.

[3] Underscored numbers in parentheses refer to Literature Cited, p. 61.


FIGURE 1.--Location of sampling sites: (1) Pullman silty clay loam; (2) Amarillo fine sandy loam; (3) Gomez fine sandy loam; (4) Altus fine sandy loam; (5) Miles fine sandy loam; (6) Pratt fine sandy loam; and (7) Grant silt loam.

dug to the desired depth and the soil profile was described by a Soil Conservation Service soil scientist. Bulk soil samples, by principal layers or horizons, were obtained from the pit wall, crushed to pass a screen with holes 2 mm. square, and stored in 1-quart ice cream cartons.

## Physical Methods

Mechanical composition of most of the horizons was determined by the pipette procedure (7). The sand fraction had been removed previously by sieving dispersed soil material through a 300-mesh screen. The sand separates were determined by sieving the dry sand 3 minutes in a standard nest of sieves. For horizons containing appreciable carbonates, the hydrometer method (2) was used. A Kelley core sampler (6) was used to obtain samples for determining bulk density of horizons.

Soil moisture tension-moisture content curves were obtained by means of a pressure-plate apparatus (18) for tensions of one bar or less. A pressure-membrane apparatus (17) was used for tensions greater than one bar. Plastic limits data were obtained according to procedures outlined by Lambe (9).

## Chemical Methods

Cation exchange capacity was measured on whole soil and on the fine clay ($< 0.2\mu$ with carbonates and organic matter removed) fraction by the sodium acetate method. Extractable ions of sodium, potassium, calcium, and magnesium in an ammonium acetate extract were determined. Calcium, sodium, and potassium were determined with the flame photometer. Magnesium was determined colorimetrically by the thiazole yellow method (13). The pH of 1:1 water-soil suspension of each sample was measured with a glass electrode.

Organic matter was determined by the Walkley and Black method (16). Free carbonates were determined from the loss in weight of a 10-g. sample reacted with 3N HCl for 3 hours at 22° C. Free iron was determined as described by Aguilera and Jackson (1).

Total silica, aluminum, iron, and calcium were determined on fine clay ($< 2\mu$) samples separated from the soil without removal of the carbonates or organic matter. Clay samples were fused in sodium carbonate and the fusate was dissolved in perchloric acid, then diluted and filtered. Filter paper containing the silica residue was digested in nitric and perchloric acid and heated to dense white perchloric acid fumes. After the digest cooled, it was diluted, made basic with sodium hydroxide, transferred to stainless steel beakers, and heated to dissolve the silica. Silica was determined in an aliquot of this solution by the molybdenum yellow method (20). Aluminum, iron, and calcium were determined on aliquots from the filtrate--aluminum by the aluminon method (15) with thioglycolic acid to complex the iron;

iron by the o-phenanthroline method (20); and calcium by the permanganate titration method (16). Aluminum and silica were also determined on samples that had been fused with sodium hydroxide and then dissolved in distilled water. On aliquots of these samples, silica was determined by the molybdenum blue method (19) and aluminum by the aluminon method. Because the two methods gave comparable results, only those from the nitric and perchloric acid digestion procedure are reported.

Loss on ignition was determined from the change in sample weight on heating to 1,000° C. in a muffle furnace.

## Mineralogical Methods

From subsamples of each horizon of the seven soils, clay separates were obtained by the method of Jackson and coworkers (5). Clay was mounted from suspension on ceramic tile plates and subjected to diagnostic treatments described by Kinter and Diamond (8).

Clay fractions of 2 $\mu$ to 0.2 $\mu$ and less than 0.2 $\mu$ were characterized by X-ray diffraction patterns and differential thermal analyses (DTA) curves. Samples for X-ray patterns were prepared by Jackson's method (4). The X-ray patterns were interpreted as described by Jackson (4) and Grim (3). DTA samples were prepared and interpreted according to Mackenzie (11) and Grim (3).

Heavy mineral studies were made on the 0.05-to 0.1-mm. sand fraction, saved from the clay separation procedure, of the native pasture profiles of Pullman, Amarillo, and Miles soils. These sands were freed of oxides by the sodium thiosulfide method of Mitchell and Mackenzie (14); efficiency of oxide removal was judged good by the appearance of quartz grains. Heavy minerals were separated at a specific gravity of 2.95 by means of tetrabromoethane. Slides of light and heavy minerals were prepared by the gelatin procedure of Marshall and Jeffries (12); grains were counted by the line-intercept method.

# RESULTS

## Pullman Silty Clay Loam

Pullman silty clay loam covers large areas of nearly level smooth surfaces of the High Plains in northwest Texas and adjoining States. It is the major soil of the "hardlands" and occurs in large continuous areas except for playas or basins. The soil is a Reddish Chestnut one and apparently has developed from aeolian deposits. Native vegetation, typically shortgrass,

consists primarily of blue grama and buffalograss. Wheat and grain sorghum are the major cultivated crops on most of the Pullman soils, but some cotton is grown in the southern extremities.

Pullman silty clay loam has accumulations of $CaCO_3$ in the lower horizons. The principal characteristic of this soil is the distinctly blocky, clayey B2t horizon. Normally, buried horizons of older soils occur at 3 to 5 feet below the surface.

The Pullman soils sampled are not significantly different from those classified as Pullman silty clay loam in recently published soil surveys of counties. For this reason they are classed as the Pullman silty clay loam type even though the textural analyses show they are clay loams.

## Pullman Silty Clay Loam (native grass)

Location: Approximately 50 feet south of county road and 0.1 mile east of the northwest corner of Section 198, Beaty, Seale, and Forwood Survey Block 9, Randall County, Tex.

A1 — 0 to 8 inches, dark brown (10YR 4/3) clay loam; dark brown (10YR 3/3) when moist; dark grayish brown (10YR 4/2) in lower part when dry; weak, fine, granular structure; hard when dry, friable when moist; noncalcareous; clear boundary.

B21t — 8 to 12 inches, dark grayish-brown (10YR 4/2) clay; very dark grayish brown (10YR 3/2) when moist; moderate, fine and very fine, subangular and irregular blockly structure; very hard when dry, very firm when moist; continuous thin clay films; few fine pores; few wormcasts; noncalcareous; clear boundary.

B22t — 12 to 23 inches, dark grayish-brown (10YR 4/2) clay; very dark grayish brown (10YR 3/2) when moist; moderate to strong, medium blocky structure; extremely hard when dry, very sticky and plastic when moist; continuous thin clay films; few very fine pores; noncalcareous; gradual boundary.

B2tca — 23 to 33 inches, brown (7.5YR 5/2) clay; dark brown (7.5YR 3/2) when moist; similar structure to that of B22t except that some of blocks tend to be platy; consistence, clay films, and porosity as in B22t; strongly calcareous with few small, soft masses of $CaCO_3$ mostly between peds; gradual boundary.

B2tbl — 33 to 46 inches, reddish-brown (5YR 5/4) clay loam; dark reddish brown (5YR 3/4) when moist; weak, fine and medium, subangular blocky and weak blocky structure; very hard when dry, sticky and plastic when wet; continuous clay films

and threads of $CaCO_3$; strongly becoming weakly calcareous in lower part; gradual boundary.

B2tb2 46 to 62 inches, reddish-brown (5YR 5/4) clay loam; reddish brown (5YR 4/4) when moist; weak, medium blocky and fine subangular blocky structure; very hard when dry, sticky and plastic when wet; few films and threads of $CaCO_3$; few black films or coatings, apparently of manganese oxide on ped surfaces; soil mass noncalcareous; abrupt boundary.

Ccab 62 to 67 inches, reddish-yellow (5YR 6/6) light clay loam; yellowish red (5YR 5/6) when moist; many soft masses of $CaCO_3$ up to 1 inch in diameter; very strongly calcareous.

## Pullman Silty Clay Loam (cultivated)

Location: Approximately 150 feet north of county road and 0.1 mile east of southwest corner of Section 197, Beaty, Seale, and Forwood Survey Block 9, Randall County, Tex.

Ap 0 to 5 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish brown (10YR 3/2) when moist; weak granular structure; friable when moist; noncalcareous; abrupt boundary.

B21t 5 to 9 inches, dark grayish-brown (10YR 4/2) light clay; very dark grayish brown (10YR 3/2) when moist; moderate fine blocky and occasional subangular blocky structure; very hard when dry, sticky and plastic when wet; continuous thin clay films; few very fine pores; noncalcareous; clear boundary.

B22t 9 to 18 inches, dark brown (7.5YR 4/2) clay; dark brown (7.5YR 3/2) when moist; moderate to strong, medium blocky structure; peds have more distinct horizontal cleavage than vertical; extremely hard when dry, sticky and plastic when wet; continuous thin clay films; few very fine pores; noncalcareous; clear boundary.

B2tca 18 to 28 inches, brown (7.5YR 4/3) clay; dark brown (7.5YR 3/3) when moist; similar structure, consistence, clay films, and porosity as in B22t; few soft masses of $CaCO_3$, mostly between peds; strongly calcareous; gradual boundary.

B2tb1 28 to 38 inches, reddish-brown (5YR 5/3) clay loam; dark reddish brown (5YR 3/2) when moist; weak medium blocky structure; ped surfaces somewhat knobby; very hard when dry, firm when moist; continuous thin clay films; few films

and threads of $CaCO_3$, films mostly on ped surfaces; few fine pores; soil mass weakly calcareous; gradual boundary.

B2tb2 38 to 53 inches, reddish-brown (5YR 5/4) clay loam; reddish brown (5YR 4/4) when moist; structure, consistence, clay films, and porosity similar to B2tb1; few films and threads of $CaCO_3$, mostly on ped surfaces; few black films, apparently of manganese oxide on larger ped surfaces; soil mass generally noncalcareous; occasional krotovina about 4 inches in diameter, one containing pellets of silty clay material about 1/2 inch in diameter; abrupt boundary.

Ccab 53 to 65 inches, reddish-yellow (5YR 6/6) clay loam; yellowish red (5YR 5/6) when moist; friable when moist; many soft masses of $CaCO_3$; very strongly calcareous.

Table 1.--Mechanical analyses of Pullman silty clay loam.

| Depth | Sand | Silt | Clay | Textural class |
|---|---|---|---|---|
| Inches | Percent | Percent | Percent | |
| CULTIVATED | | | | |
| 0-5 | 39.2 | 31.6 | 29.2 | Clay loam. |
| 5-9 | 31.6 | 29.6 | 38.8 | Do. |
| 9-18 | 23.5 | 32.7 | 43.8 | Clay. |
| 18-28 | 24.8 | 32.6 | 42.6 | Do. |
| 28-38 | 27.8 | 34.3 | 37.9 | Clay loam. |
| 38-53 | 29.6 | 31.8 | 38.6 | Do. |
| 53-65 | 29.4 | 30.9 | 39.7 | ([1]) |
| 65-76 | 41.9 | 21.2 | 36.9 | ([1]) |
| NATIVE GRASS | | | | |
| 0-8 | 41.8 | 31.6 | 26.6 | Clay loam. |
| 8-23 | 26.6 | 29.5 | 43.9 | Clay. |
| 23-33 | 27.9 | 33.2 | 38.9 | Clay loam. |
| 33-46 | 32.2 | 32.2 | 35.6 | Do. |
| 46-62 | 36.2 | 28.8 | 35.0 | Do. |
| 62-67 | 49.9 | 18.8 | 31.3 | ([1]) |
| 67-76 | 40.5 | 30.9 | 28.6 | ([1]) |

[1] Appreciable quantities of $CaCO_3$ were destroyed during the mechanical analysis procedure. Because of this destruction, laboratory texture determinations differ from field estimations of texture.

Table 2.--Soil-moisture relationships for Pullman silty clay loam.

| Depth | Soil-moisture tension[1] for-- | | | | Bulk density |
|---|---|---|---|---|---|
| | 1/3 bar | 1 bar | 5 bars | 15 bars | |
| Inches | Percent moisture by weight | | | | G./cc. |
| **CULTIVATED** | | | | | |
| 0-5 | 28.3 | 19.2 | 13.8 | 11.1 | 1.39 |
| 5-9 | 32.0 | 24.0 | 18.9 | 15.4 | 1.50 |
| 9-18 | 34.8 | 26.7 | 21.8 | 17.1 | 1.50 |
| 18-28 | 34.0 | 26.2 | 21.3 | 16.4 | 1.50 |
| 28-38 | 32.5 | 24.4 | 21.0 | 15.1 | 1.58 |
| 38-53 | 32.5 | 25.0 | 19.8 | 15.8 | 1.59 |
| 53-65 | 30.0 | 24.6 | 21.9 | 11.3 | 1.67 |
| 65-76 | 29.8 | -- | -- | 11.6 | -- |
| -- | -- | -- | -- | -- | -- |
| 80-85 | 28.9 | 23.1 | 17.4 | 12.6 | -- |
| **NATIVE GRASS** | | | | | |
| 0-8 | 25.9 | 18.6 | 12.9 | 10.2 | 1.22 |
| 8-23 | 33.2 | 25.6 | 20.4 | 17.1 | 1.43 |
| 23-33 | 31.6 | 23.1 | 18.1 | 14.5 | 1.54 |
| 33-46 | 32.4 | 23.8 | 18.0 | 14.5 | 1.49 |
| 46-62 | 32.3 | 24.2 | 18.7 | 15.0 | 1.58 |
| 62-67 | 29.0 | 24.4 | 16.8 | 10.2 | 1.59 |
| 67-77 | 28.4 | -- | -- | 9.9 | -- |
| 82-85 | -- | 21.6 | -- | 10.7 | -- |

[1] The 1/3-bar values were determined on disturbed samples and should not be used to approximate field capacity of clay loam or clay horizons. However, unpublished data of H. M. Taylor on similar Southern Great Plains soils show no appreciable effects of bulk density upon the 1/3-bar values of horizons that are sandy clay loam or coarser in texture.

Table 3.--Atterberg limits for Pullman silty clay loam.

| Horizon | Liquid limit | Plastic limit | Plasticity index[1] |
|---|---|---|---|
| | | CULTIVATED | |
| Inches | Percent | Percent | |
| 0-5 | 30.5 | 20.4 | 10.1 |
| 5-8 | 30.3 | 20.8 | 9.5 |
| 8-13 | 37.5 | 22.2 | 15.3 |
| 13-19 | 46.4 | 25.8 | 20.6 |
| 19-28 | 44.0 | 24.2 | 19.8 |
| 28-38 | 39.4 | 22.0 | 17.4 |
| 38-53 | 36.3 | 21.5 | 14.8 |
| 53-65 | 38.3 | 21.4 | 16.9 |
| 65-76 | 33.0 | 20.2 | 12.8 |
| | | NATIVE GRASS | |
| 0-8 | 34.4 | 21.6 | 12.8 |
| 8-12 | 35.2 | 25.9 | 9.3 |
| 12-23 | 36.1 | 24.4 | 11.7 |
| 23-33 | 37.6 | 21.2 | 16.4 |
| 33-46 | 36.0 | 22.6 | 13.4 |
| 46-62 | 38.4 | 22.3 | 16.1 |
| 62-67 | 32.6 | 22.7 | 9.9 |

[1] The plasticity index is the numerical difference between the liquid and plastic limits. The index increases with increasing soil plasticity.

Table 4.--Chemical data for Pullman silty clay loam.

CULTIVATED

| Depth | Extractable ions | | | | C.E.C. | pH | O.M. | $CaCO_3$ equiv. | Free $Fe_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|
| | Na | K | Ca | Mg | | | | | |
| Inches | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | | Per-cent | Per-cent | Per-cent |
| 0-5 | 0.16 | 1.28 | 9.0 | 2.7 | 18.4 | 6.5 | 1.58 | -- | 0.29 |
| 5-9 | .33 | 1.15 | 13.7 | 3.5 | 19.6 | 6.5 | 1.29 | -- | .22 |
| 9-18 | 1.21 | .94 | [1] 40.0 | 3.2 | 20.0 | 7.5 | .94 | 0.5 | .30 |
| 18-28 | 1.66 | .92 | [1] 40.0 | 3.7 | 23.9 | 7.6 | .69 | 3.5 | .25 |
| 28-38 | 1.96 | .80 | [1] 37.5 | 3.7 | 20.9 | 7.7 | .63 | 3.5 | .19 |
| 38-53 | 1.87 | .74 | [1] 33.0 | 3.7 | 17.4 | 7.6 | .22 | 2.7 | .21 |
| 53-65 | 1.66 | .31 | [1] 44.0 | -- | -- | -- | .35 | 45.0 | .11 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 80-85 | 1.91 | .49 | [1] 40.0 | .6 | 10.4 | 7.7 | .16 | 13.2 | .28 |

NATIVE GRASS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0-8 | 0.24 | 0.69 | 14.0 | 2.0 | 17.4 | 6.4 | 2.52 | -- | 0.33 |
| 8-23 | 1.17 | 1.13 | [1] 21.0 | 4.5 | 20.9 | 7.0 | 1.45 | .9 | .23 |
| 23-33 | 2.26 | .88 | [1] 35.0 | 4.7 | 21.7 | 7.7 | .76 | 4.3 | .19 |
| 33-46 | 2.13 | .77 | [1] 30.5 | 4.8 | 20.4 | 7.7 | .44 | 2.0 | .18 |
| 46-62 | 2.26 | .94 | [1] 29.0 | 4.7 | 20.4 | 7.3 | .38 | 1.6 | .22 |
| 62-67 | 1.87 | .30 | [1] 37.5 | 3.2 | 17.4 | 7.6 | .35 | 40.9 | .10 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 82-85 | 1.61 | .39 | [1] 37.5 | -- | -- | -- | .22 | 29.3 | .10 |

[1] Free carbonates present.

Table 5.--Chemical analyses of the clay fraction from Pullman silty clay loam.

CULTIVATED

| Depth | C.E.C.[1] | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | Weight loss on ignition | $\frac{SiO_2}{R_2O_3}$ |
|---|---|---|---|---|---|---|---|
| Inches | Meq./ 100 g. | Percent | Percent | Percent | Percent | Percent | |
| 0-5 | 73.3 | 46.1 | 13.5 | 7.0 | 6.3 | 14.7 | 4.37 |
| 5-9 | 86.0 | 41.6 | 14.3 | 6.9 | 6.0 | 13.4 | 3.78 |
| 9-18 | 83.2 | 43.7 | 17.9 | 6.7 | 9.1 | 11.9 | 3.36 |
| 18-28 | 83.5 | 39.2 | 15.0 | 4.0 | 8.9 | 9.9 | 3.80 |
| 28-38 | 79.5 | 39.2 | 22.6 | 6.3 | 10.5 | 9.8 | 2.52 |
| 38-53 | 83.8 | 40.8 | 16.9 | 8.8 | 10.8 | 9.5 | 3.10 |
| 53-65 | 93.4 | 16.6 | 7.2 | 3.1 | 34.3 | 23.0 | 3.08 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 80-85 | 92.0 | 31.2 | 22.4 | 7.3 | 20.2 | 12.4 | 1.97 |
| | | | NATIVE GRASS | | | | |
| 0-8 | 76.1 | 45.6 | 17.4 | 7.5 | 6.8 | 13.5 | 3.51 |
| 8-23 | 80.6 | 40.1 | 16.9 | 5.6 | 9.6 | 15.3 | 3.34 |
| 23-33 | 83.7 | 39.1 | 17.0 | 5.8 | 11.8 | 13.2 | 3.23 |
| 33-46 | 81.3 | 41.9 | 16.8 | 7.1 | 9.4 | 10.8 | 3.33 |
| 46-62 | 94.2 | 40.8 | 17.3 | 6.7 | 8.9 | 9.2 | 3.21 |
| 62-67 | 90.2 | 23.5 | 9.4 | 3.6 | 28.8 | 20.4 | 3.40 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 82-85 | 92.6 | 22.8 | 10.1 | 3.5 | 25.6 | 14.9 | 3.14 |

[1] Na acetate method on $< 0.2\mu$ clay with carbonates and organic matter removed; other analyses on $< 2\mu$ clay.

Table 6.--Clay minerals[1] present in Pullman silty clay loam.

| Cultivated | | | Native grass | | |
|---|---|---|---|---|---|
| Depth | Minerals | | Depth | Minerals | |
| Inches | <0.2μ | 0.2-2μ | Inches | <0.2μ | 0.2-2μ |
| 0-5 | MI/K | IK | 0-8 | MI/K | IMK |
| 5-9 | MI/K | IK | 8-23 | MI/K | IMK |
| 9-18 | MI/K | IMK | 23-33 | MI | IKM |
| 18-28 | MI/K | IKM | 33-46 | MI | IMK |
| 28-38 | M/IK | IKM | 46-62 | MI | IMK |
| 38-53 | MI/K | IMK | 62-67 | MI | MIK |
| 53-65 | M/I | KMI | -- | -- | -- |
| -- | -- | -- | 82-85 | MI | MIK |
| 80-85 | MI/K | MIK | -- | -- | -- |

[1] I = illite, K = kaolinite, M = montmorillonite. The most abundant minerals, for both dominant and minor amounts, are indicated first in the sequences. Minor amounts present are indicated after the diagonal; e.g., MI/K is montmorillonite and illite dominant material with a minor amount of kaolinite.

Table 7.--Mineralogy of the heavy and light mineral suites of Pullman silty clay loam (native grass).

HEAVY (SP.GR. > 2.95)

| Mineral[1] | Depth (inches) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0-8 | 8-23 | 23-33 | 33-46 | 46-62 | 62-67 | 82-85 |
| | Percent | Percent | Percent | Percent | Percent | Percent | Percent |
| Opaque | 49.5 | 47.7 | 52.9 | 54.6 | 50.1 | 45.9 | 45.6 |
| Garnet | 2.1 | 1.9 | 4.1 | 2.6 | 2.4 | 2.6 | 3.8 |
| Epidote[2] | 17.3 | 15.7 | 16.2 | 15.6 | 17.2 | 10.3 | 12.2 |
| Amphibole | 6.6 | 13.0 | 7.4 | 7.2 | 8.7 | 15.5 | 12.7 |
| Pyroxene | 3.5 | 1.7 | 1.9 | .5 | .7 | 3.3 | 5.2 |
| Zircon | 7.1 | 8.0 | 7.4 | 11.3 | 12.0 | 11.2 | 8.5 |
| Tourmaline | 8.5 | 7.2 | 5.8 | 3.6 | 4.2 | 5.5 | 6.8 |
| Others | 5.4 | 4.8 | 4.3 | 4.6 | 4.7 | 5.7 | 5.2 |
| Zircon/ tourmaline | .84 | 1.10 | 1.28 | 3.14 | 2.84 | 2.04 | 1.24 |

See footnotes at end of table.

Table 7.--Mineralogy of the heavy and light mineral suites of Pullman silty clay loam (native grass)--Continued

LIGHT (SP.GR. < 2.95)

| Mineral[1] | Depth (inches) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0-8 | 8-23 | 23-33 | 33-46 | 46-62 | 62-67 | 82-85 |
| | Percent | Percent | Percent | Percent | Percent | Percent | Percent |
| Quartz | 81.1 | 76.8 | 77.0 | 84.5 | 82.5 | 80.2 | 84.3 |
| Orthoclase | 13.6 | 18.3 | 16.1 | 14.0 | 14.7 | 15.1 | 9.7 |
| Microcline | 3.0 | 2.7 | 4.1 | 1.5 | .7 | 2.0 | 1.6 |
| Others | 2.3 | 2.2 | 2.8 | 0 | 2.1 | 2.7 | 4.4 |

[1] Calculated for each horizon as percent of the total number of particles of the heavy, or light, mineral suite.
[2] Includes zoisite.

## Amarillo Fine Sandy Loam

Amarillo fine sandy loam is a moderately sandy Reddish Chestnut soil occurring extensively in the southern High Plains of Texas and New Mexico. It is developed from unconsolidated, moderately sandy, calcareous sediments, probably of aeolian origin. Much of this soil is irrigated. The major cultivated crops are cotton and grain sorghum.

This soil has a brown to reddish-brown fine sandy loam surface layer with a reddish-brown sandy clay loam subsoil, or B2t horizon, underlain by a distinct zone of $CaCO_3$ accumulation at 30 to 75 inches below the surface. It occupies the nearly level to gently sloping surfaces. The surface and internal drainages are medium.

The profiles sampled are representative of the Amarillo fine sandy loam type except for having relatively weak zones of $CaCO_3$ accumulation.

### Amarillo Fine Sandy Loam (native grass)

Location: Three hundred feet east and 100 feet north of the southwest corner of Section 28, Sabine County School Land, Hale County, Tex.

A1 0 to 6 inches, dark brown (7.5YR 4/3) fine sandy loam; dark brown (7.5YR 3/2) when moist; weak, granular structure; very friable when moist; noncalcareous; upper 1 to 2 inches is apparently overblow; clear boundary.

B21t 6 to 19 inches, reddish-brown (5YR 4/4) sandy clay loam; dark reddish brown (5YR 3/4) when moist; moderate very coarse prismatic and weak fine subangular blocky structure; thin clay films mostly on prism faces; very hard when dry, friable when moist; many medium and fine pores; many wormcasts; noncalcareous; gradual boundary.

B22t 19 to 40 inches, yellowish-red (5YR 4/6) sandy clay loam; yellowish red (5YR 3/6) when moist; moderate very coarse prismatic and fine subangular blocky structure; thin clay films mostly on prism faces; very hard when dry, friable when moist; many fine pores; many wormcasts; noncalcareous; diffuse boundary.

B23t 40 to 54 inches, yellowish-red (5YR 4.5/6) sandy clay loam; (5YR 4/6) when moist; moderate, very coarse prismatic and fine subangular blocky structure; thin clay films mostly on prism faces; very hard when dry, firm when moist; many pores and wormcasts; noncalcareous; gradual boundary.

Ccal 54 to 75 inches, yellowish-red (5YR 5/6) light sandy clay loam; (5YR 4/6) when moist; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist; few nests of wormcasts; many films and threads of $CaCO_3$; many $CaCO_3$ concretions mostly 1/2 to 2 inches in diameter; soil mass weakly calcareous; clear boundary.

Cca2 75 to 100 inches, reddish-yellow (5YR 6/6) fine sandy loam; yellowish red (5YR 5/6) when moist; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist; many films and threads of $CaCO_3$; many $CaCO_3$ concretions up to 2 inches in diameter; soil mass strongly calcareous; gradual boundary.

C 100 to 120 inches, similar to horizon above, but $CaCO_3$ decreases with depth.

Note: Roots readily penetrate peds and decrease to a few at 4 feet. Prisms are usually about 6 inches across and nearly continuous from surface to the Cca horizon. The vertical prism faces are knobby and somewhat irregular and have thin, nearly continuous, clay films.

## Amarillo Fine Sandy Loam (cultivated)

Location: Three hundred feet east and 100 feet south of the northwest corner of Section 27, Sabine County School Land, Hale County, Tex.

Ap 0 to 8 inches, reddish-brown (5YR 4/4) fine sandy loam; dark reddish brown (5YR 3/4) when moist; weak granular

structure, friable when moist; lower 2 1/2 inches of horizon more compact than upper part; abrupt boundary.

B21t 8 to 17 inches, reddish-brown (5YR 4/4) sandy clay loam; dark reddish brown (5YR 3/4) when moist; weak to moderate, very coarse, prismatic and fine, subangular blocky structure; thin clay films mostly on prism faces; very hard when dry, friable when moist; many fine pores and wormcasts; noncalcareous; gradual boundary.

B22t 17 to 23 inches, reddish-brown (5YR 4/4) sandy clay loam; dark reddish brown (5YR 3/4) when moist; moderate, very coarse, prismatic and fine, subangular blocky structure; thin clay films mostly on vertical prism faces; very hard when dry, friable when moist; many fine pores; many wormcasts; noncalcareous, diffuse boundary.

B23t 23 to 32 inches, red (2.5YR 4/6) sandy clay loam; dark red (2.5YR 3/6) when moist; structure as in B22t but weaker; similar consistence, porosity, and wormcasts to B22t; noncalcareous; gradual boundary.

B3 32 to 65 inches, yellowish-red (5YR 5/6) fine sandy loam; yellowish red (5YR 4/6) when moist; weak, subangular, blocky structure; hard when dry, friable when moist; many films and threads of $CaCO_3$; soil mass generally noncalcareous; gradual boundary.

Cca 65 to 77 inches, reddish-yellow (5YR 6/6) heavy fine sandy loam; yellowish red (5YR 5/6) when moist; friable when moist; many films and threads of $CaCO_3$; many small soft masses and concretions of $CaCO_3$, mostly 1/4 to 1 inch in diameter; strongly calcareous; gradual boundary.

C 77 to 96 inches, reddish-yellow (5YR 6/6) sandy clay loam; yellowish red (5YR 5/6) when moist; friable when moist; calcareous with many $CaCO_3$ concretions.

Table 8.--Mechanical analyses of Amarillo fine sandy loam.

CULTIVATED

| Depth | Sand | Silt | Clay | Textural class |
|---|---|---|---|---|
| Inches | Percent | Percent | Percent | |
| 0-4 | 75.1 | 6.9 | 18.0 | Fine sandy loam. |
| 4-8 | 79.4 | 6.4 | 14.2 | Do. |
| 8-17 | 62.1 | 8.8 | 29.1 | Sandy clay loam. |
| 17-23 | 65.9 | 5.1 | 29.0 | Do. |
| 23-32 | 74.7 | 3.3 | 22.0 | Do. |
| 32-65 | 79.4 | 7.5 | 13.1 | Fine sandy loam. |
| -- | -- | -- | -- | -- |
| 73-77 | 66.0 | 14.8 | 19.2 | Fine sandy loam.[1] |
| -- | -- | -- | -- | -- |
| 90-94 | 56.0 | 18.8 | 25.2 | Sandy clay loam.[1] |
| | | NATIVE GRASS | | |
| 0-1 | 67.8 | 14.2 | 18.0 | Fine sandy loam. |
| 1-3 | 80.0 | 7.2 | 12.8 | Do. |
| 3-6 | 73.8 | 6.2 | 20.0 | Do. |
| 6-19 | 67.3 | 6.5 | 26.2 | Sandy clay loam. |
| 19-30 | 70.1 | 9.1 | 20.8 | Do. |
| 30-40 | 70.8 | 8.6 | 20.6 | Do. |
| 40-54 | 71.7 | 6.3 | 22.0 | Do. |

[1] Because appreciable quantities of carbonates were present in this horizon, a hydrometer analysis was used to determine particle-size distribution.

Table 9.--Soil-moisture relationships for Amarillo fine sandy loam.

CULTIVATED

| Depth | Soil-moisture tension for-- | | | | Bulk density |
|---|---|---|---|---|---|
| | 1/3 bar | 1 bar | 5 bars | 15 bars | |
| Inches | ---------Percent moisture by weight--------- | | | | G./cc. |
| 0-4 | 13.5 | 10.2 | 7.5 | 6.0 | 1.35 |
| 4-8 | 10.4 | 7.5 | 5.7 | 4.7 | 1.37 |
| 8-17 | 19.0 | 15.1 | 11.9 | 9.8 | 1.42 |
| 17-23 | 19.7 | 15.2 | 12.3 | 10.0 | 1.47 |
| 23-32 | 17.3 | 13.0 | 10.3 | 8.4 | 1.52 |
| 32-65 | 15.4 | 11.4 | 8.5 | 7.0 | 1.65 |
| 65-73 | 14.8 | -- | -- | 6.3 | 1.77 |
| 73-77 | 14.2 | 9.9 | 6.9 | 5.5 | 1.79 |
| -- | -- | -- | -- | -- | -- |
| 90-94 | 18.5 | 12.9 | 9.2 | 7.1 | -- |
| NATIVE GRASS | | | | | |
| 0-2 | 9.6 | 7.2 | 5.0 | 4.1 | 1.40 |
| 2-6 | 13.7 | 10.7 | 7.9 | 6.7 | 1.40 |
| 6-19 | 17.4 | 14.1 | 11.2 | 9.5 | 1.42 |
| 19-40 | 15.4 | 12.0 | 8.9 | 7.2 | 1.45 |
| 40-54 | 11.9 | 9.7 | 6.6 | 5.4 | 1.65 |
| 54-64 | 20.1 | -- | -- | 9.3 | 1.69 |
| 64-74 | 20.9 | -- | -- | 9.3 | 1.81 |

Table 10.--Atterberg limits for Amarillo fine sandy loam.

CULTIVATED

| Horizon | Liquid limit | Plastic limit | Plasticity index[1] |
|---|---|---|---|
| Inches | Percent | Percent | |
| 0-4 | 16.9 | 14.6 | 2.3 |
| 4-8 | 15.5 | 14.6 | .9 |
| 8-17 | 25.6 | 16.6 | 9.0 |
| 17-23 | 26.8 | 17.3 | 9.5 |
| 23-32 | 26.9 | 16.4 | 10.5 |
| 32-43 | 23.5 | 16.7 | 6.8 |
| 43-55 | 23.1 | 17.3 | 5.8 |
| 55-65 | 21.9 | 17.0 | 4.9 |
| 65-77 | 19.3 | 16.3 | 3.0 |
| NATIVE GRASS | | | |
| 0-6 | 17.7 | 14.2 | 3.5 |
| 6-19 | 25.0 | 18.4 | 6.6 |
| 19-30 | 24.6 | 15.9 | 8.7 |
| 30-40 | 23.0 | 15.9 | 7.1 |
| 40-54 | 27.8 | 17.2 | 10.6 |
| 54-64 | 24.2 | 16.0 | 8.2 |
| 64-74 | 25.5 | 15.4 | 10.1 |

[1] See footnote, table 3.

Table 11.--Chemical data for Amarillo fine sandy loam.

CULTIVATED

| Depth | Extractable ions | | | | C.E.C. | pH | O.M. | $CaCO_3$ equiv. | Free $Fe_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|
| | Na | K | Ca | Mg | | | | | |
| Inches | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | | Per- cent | Per- cent | Per- cent |
| 0-4 | 0.13 | 0.64 | 8.0 | 1.9 | 10.0 | 7.1 | 1.01 | -- | 0.15 |
| 4-8 | .17 | .43 | 6.5 | 1.4 | 9.8 | 6.1 | 1.39 | -- | .28 |
| 8-17 | .10 | .51 | 12.2 | 2.4 | 15.2 | 6.3 | 1.07 | -- | .32 |
| 17-23 | .13 | .44 | 12.5 | 3.2 | 17.4 | 6.6 | .79 | -- | .34 |
| 23-32 | .14 | .75 | 9.0 | 1.7 | 12.1 | 6.8 | .41 | -- | .29 |
| 32-65 | .17 | .62 | 8.0 | 3.2 | 12.1 | 6.9 | .16 | -- | .25 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 73-77 | .16 | .44 | 10.0 | 2.8 | 9.4 | 7.7 | .09 | 5.7 | .12 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 90-94 | .23 | .56 | 10.6 | 3.1 | 10.9 | 7.7 | .09 | 7.5 | .17 |
| NATIVE GRASS | | | | | | | | | |
| 0-1 | 0.10 | 0.85 | 7.4 | 2.8 | 13.5 | 6.1 | 2.36 | -- | 0.29 |
| 1-3 | .08 | .45 | 4.9 | 1.1 | 8.5 | 5.2 | 1.07 | -- | .39 |
| 3-6 | .12 | .53 | 6.7 | 2.2 | 10.4 | 5.9 | 1.16 | -- | .30 |
| 6-19 | .16 | .72 | 9.0 | 3.3 | 13.9 | 6.0 | 1.51 | -- | .39 |
| 19-40 | .21 | .54 | 7.9 | 3.1 | 10.9 | 6.3 | .41 | -- | .31 |
| 40-45 | .13 | .42 | 6.5 | 2.5 | 9.2 | 6.8 | .25 | -- | .34 |

Table 12.--Chemical analyses of the clay fraction from Amarillo fine sandy loam.

CULTIVATED

| Depth | C.E.C.[1] | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | Weight loss on ignition | $\frac{SiO_2}{R_2O_3}$ |
|---|---|---|---|---|---|---|---|
| Inches | Meq./ 100 g. | Percent | Percent | Percent | Percent | Percent | |
| 0-4 | 62.9 | 30.5 | 14.7 | 5.7 | 14.0 | 11.6 | 2.82 |
| 4-8 | 67.4 | 28.7 | 14.0 | 4.8 | 9.7 | 9.7 | 2.85 |
| 8-17 | 72.8 | 36.4 | 18.2 | 7.6 | 6.1 | 8.9 | 2.68 |
| 17-23 | 73.8 | 35.7 | 17.2 | 6.2 | 8.9 | 9.5 | 2.86 |
| 23-32 | 73.5 | 38.0 | 18.3 | 6.3 | 10.3 | 9.1 | 2.89 |
| 32-65 | 80.1 | 34.7 | 18.4 | 7.5 | 11.9 | 8.9 | 2.53 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 73-77 | 96.6 | 27.7 | 12.8 | 5.3 | 13.3 | 10.5 | 2.90 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 90-94 | 92.8 | 32.7 | 15.2 | 3.9 | 14.8 | 9.5 | 3.14 |

NATIVE GRASS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0-1 | 71.2 | 36.6 | 16.5 | 3.3 | 14.6 | 11.4 | 3.34 |
| 1-3 | 70.7 | 32.5 | 15.5 | 3.1 | 14.4 | 8.1 | 3.15 |
| 3-6 | 65.3 | 36.1 | 16.2 | 5.3 | 11.6 | 10.3 | 3.13 |
| 6-19 | 66.3 | 43.7 | 18.6 | 5.5 | 9.6 | 9.7 | 3.35 |
| 19-40 | 66.6 | 39.2 | 16.3 | 5.0 | 11.2 | 8.6 | 3.41 |
| 40-45 | 78.0 | 37.6 | 15.1 | 4.7 | 12.4 | 8.7 | 3.52 |

[1] Na acetate method on $< 0.2\mu$ clay with carbonates and organic matter removed; other analyses on $< 2\mu$ clay.

Table 13.--Clay minerals[1] present in Amarillo fine sandy loam.

| Cultivated | | Native grass | |
|---|---|---|---|
| Depth | Minerals | Depth | Minerals |

| Inches | <0.2μ | 0.2-2μ | Inches | <0.2μ | 0.2-2μ |
|---|---|---|---|---|---|
| 0-4 | MI/K | IK/M | 0-1 | MI | IK/M |
| 4-8 | MI/K | IK/M | 1-3 | MI | IK/M |
| 8-17 | MI/K | IK/M | 3-6 | MI/K | IK/M |
| 17-23 | MI/K | IK/M | 6-19 | MI/K | IK/M |
| 23-32 | MI/K | IK/M | 19-40 | MIK | IK/M |
| 32-65 | MI/K | IK/M | 40-45 | MI/K | IMK |
| -- | -- | -- | | | |
| 90-94 | M/K | IK/M | | | |

[1] I = illite, K = kaolinite, M = montmorillonite. The most abundant minerals, for both dominant and minor amounts, are indicated first in the sequences. Minor amounts present are indicated after the diagonal; e.g., MI/K is montmorillonite and illite dominant mineral with a minor amount of kaolinite.

Table 14.--Mineralogy of the heavy and light mineral suites of Amarillo fine sandy loam (native grass).

HEAVY (SP.GR. > 2.95)

| Mineral[1] | Depth (inches) | | | | | |
|---|---|---|---|---|---|---|
| | 0-1 | 1-3 | 3-6 | 6-19 | 19-40 | 40-45 |
| | Percent | Percent | Percent | Percent | Percent | Percent |
| Opaque | 57.8 | 62.4' | 63.6 | 62.4 | 72.7 | 61.4 |
| Garnet | 3.8 | 2.4 | 2.1 | 2.0 | 1.1 | 2.6 |
| Epidote[2] | 12.7 | 8.7 | 11.1 | 8.5 | 9.2 | 13.1 |
| Amphibole | 3.1 | 2.7 | 1.2 | 2.0 | 1.7 | 2.1 |
| Pyroxene | 1.6 | .5 | .5 | .8 | .5 | 1.7 |
| Zircon | 10.0 | 15.0 | 14.9 | 14.4 | 9.0 | 10.0 |
| Tourmaline | 7.4 | 4.9 | 2.8 | 5.9 | 2.5 | 4.8 |
| Others | 3.6 | 3.4 | 3.8 | 4.0 | 3.3 | 4.3 |
| Zircon/tourmaline | 1.36 | 3.08 | 5.30 | 2.42 | 3.59 | 2.09 |

See footnotes at end of table.

Table 14.--Mineralogy of the heavy and light mineral suites of Amarillo fine sandy loam (native grass)--Continued

LIGHT (SP.GR. < 2.95)

| Mineral[1] | Depth (inches) | | | | | |
|---|---|---|---|---|---|---|
| | 0-1 | 1-3 | 3-6 | 6-19 | 19-40 | 40-45 |
| | Percent | Percent | Percent | Percent | Percent | Percent |
| Quartz | 89.2 | 88.4 | 82.3 | 87.6 | 82.3 | 81.4 |
| Orthoclase | 7.6 | 8.9 | 12.3 | 8.8 | 11.3 | 11.4 |
| Microcline | 1.0 | 2.4 | 3.5 | 1.7 | 3.1 | 4.3 |
| Others | 2.2 | .3 | 1.9 | 1.9 | 3.3 | 2.9 |

[1] Calculated for each horizon as percent of the total number of particles of the heavy, or light, mineral suite.
[2] Includes zoisite.

## Gomez Fine Sandy Loam

Gomez fine sandy loam normally occurs in shallow valleys and basins in the southern High Plains of Texas and New Mexico. The soil is a relatively light-colored Calcisol with a moderately sandy subsoil; it is developed in strongly calcareous unconsolidated sediments. The surface horizons probably are aeolian in origin or have been modified by wind. Some of the Gomez fine sandy loam is irrigated and cultivated to cotton and grain sorghums.

The Gomez soil normally has a grayish-brown, calcareous, fine sandy loam surface horizon and a very strongly calcareous, nearly white Cca horizon of sandy clay loam texture at depths of 20 to 50 inches below the surface. This soil has slow to good surface drainage and good internal drainage. A water table occurs below 10 to 25 feet.

### Gomez Fine Sandy Loam (native grass)

Location: Two hundred and twenty feet west northwest of southeast corner of Section 4, Block 28, T. 2 N., T and P survey, Martin County, Tex.

A1 0 to 6 inches, grayish-brown (10YR 5/2) fine sandy loam; dark brown (10YR 3/3) when moist: weak, granular structure;

very friable when moist; noncalcareous in upper few inches, grading to strongly calcareous in lower part; gradual boundary.

AC1 — 6 to 20 inches, light brownish-gray (10YR 6/2) fine sandy loam; brown (10YR 4/3) when moist; weak, fine, subangular blocky and granular structure; hard when dry, friable when moist; many fine pores; many wormcasts; fine films and threads of $CaCO_3$ increasing with depth; strongly calcareous; gradual boundary.

AC2 — 20 to 27 inches, light brownish-gray (10YR 6/2) sandy clay loam; brown (10YR 5/3) when moist; similar structure and consistence to that of AC1; many pores and wormcasts; many films and threads of $CaCO_3$; strongly calcareous; clear boundary.

B2cab — 27 to 40 inches, pale brown (10YR 6/3) clay; brown (10YR 5/3) when moist; weak to moderate, fine, subangular blocky structure; very hard when dry, firm when moist; estimated 15 to 20 percent by volume of soft masses and concretions of $CaCO_3$ mostly about 3/8 inch in diameter; very strongly calcareous; gradual boundary.

Ccab — 40 to 60 inches, white (10YR 8/2) sandy clay loam; light gray (10YR 7/2) when moist; weakly cemented; very strongly calcareous with about 40 percent segregated $CaCO_3$; apparently diffuse boundary.

Cb — 60 to 85 inches, white (10YR 8/2) sandy clay loam; light gray (10YR 7/2) when moist; very strongly calcareous, with a few cherty caliche concretions near bottom of the horizon.

## Gomez Fine Sandy Loam (cultivated)

Location: Twelve hundred feet north-northwest and 100 feet east of southwest corner of Section 34, Block 37, T. 2 N., T and P survey, Martin County, Tex.

Ap — 0 to 8 inches, grayish-brown (10YR 5/2) fine sandy loam; very dark grayish brown (10YR 3/2) when moist; weak, granular structure; friable when moist; strongly calcareous; abrupt boundary.

AC1 — 8 to 13 inches, grayish-brown (10YR 5/2) fine sandy loam; dark grayish brown (10YR 4/2) when moist; weak, granular structure; slightly hard when dry, friable when moist; many fine and medium pores; many wormcasts; strongly calcareous; clear boundary.

AC2 13 to 24 inches, pale brown (10YR 6/3) fine sandy loam; brown (10YR 5/3) when moist; weak, fine, subangular blocky and granular structure; slightly hard when dry, friable when moist; many fine pores and wormcasts; few films and threads of $CaCO_3$; very few small soft masses of $CaCO_3$; very strongly calcareous; gradual boundary.

AC3 24 to 34 inches, very pale brown (10YR 7/3) fine sandy loam; pale brown (10YR 6/3) when moist; similar structure and consistence to that of AC2; many fine pores; few nests of wormcasts; many soft masses of $CaCO_3$ 1/4 to 1/2 inch in diameter; very strongly calcareous; clear boundary.

Cca 34 to 45 inches, light gray (10YR 7/2) fine sandy loam; light brownish gray (10YR 6/2) when moist; massive and porous; very hard when dry, friable when moist; estimated 30 percent by volume of segregated $CaCO_3$; very strongly calcareous; abrupt boundary.

Bb 45 to 52 inches, grayish-brown (10YR 5/2) clay loam; dark grayish brown (10YR 4/2) when moist; moderate, fine, subangular blocky structure; very hard when dry, firm when moist; few fine pores; few films and threads of $CaCO_3$; soil mass noncalcareous in upper part, weakly calcareous in lower; gradual boundary.

Ccab 52 to 75 inches, white (10YR 8/2) clay loam; light gray (10YR 7/2) when moist; weakly cemented; very hard when dry; estimated 40 percent segregated $CaCO_3$; very strongly calcareous; diffuse boundary.

Cb 75 to 90 inches, light gray (10YR 7/2) fine sandy loam; light brownish gray (10YR 6/2) when moist; similar to Ccab horizon but about half as much segregated $CaCO_3$; diffuse boundary.

Table 15.--Mechanical analyses[1] of Gomez fine sandy loam.

| Depth | Sand | Silt | Clay | Textural class |
|---|---|---|---|---|
| | | CULTIVATED | | |
| Inches | Percent | Percent | Percent | |
| 0-8 | 62.0 | 27.0 | 11.0 | Fine sandy loam. |
| 8-13 | 56.8 | 27.0 | 16.2 | Do. |
| 13-24 | 55.6 | 28.2 | 16.2 | Do. |
| 24-34 | 68.0 | 16.0 | 16.0 | Do. |
| 34-45 | 64.0 | 18.0 | 18.0 | Do. |
| | | NATIVE GRASS | | |
| 0-6 | 66.0 | 24.8 | 9.2 | Fine sandy loam. |
| 6-20 | 53.6 | 29.2 | 17.2 | Do. |
| 20-27 | 47.0 | 34.8 | 18.2 | Do. |
| 27-40 | 26.0 | 26.8 | 47.2 | Clay. |
| 40-52 | 36.8 | 18.0 | 45.2 | Do. |
| 52-60 | 54.8 | 16.0 | 29.2 | Sandy clay loam. |
| 60-72 | 72.0 | 10.8 | 17.2 | Fine sandy loam. |
| 72-80 | 66.0 | 14.0 | 20.0 | Sandy clay loam. |
| 80-85 | 66.0 | 12.0 | 22.0 | Do. |

[1] Because excess quantities of carbonates were present in all soil horizons, a hydrometer analysis was used to determine particle-size distribution.

Table 16.--Soil-moisture relationships for Gomez fine sandy loam.

CULTIVATED

| Depth | Soil-moisture tension for-- | | | | Bulk density |
|---|---|---|---|---|---|
| | 1/3 bar | 1 bar | 5 bars | 15 bars | |
| Inches | ---------Percent moisture by weight--------- | | | | G./cc. |
| 0-8 | 10.6 | 8.5 | 6.4 | 5.4 | 1.35 |
| 8-13 | 12.7 | 10.6 | 8.1 | 7.1 | 1.32 |
| 13-24 | 15.3 | 12.1 | 9.3 | 8.1 | 1.41 |
| 24-34 | 20.5 | 16.5 | 12.2 | 10.7 | 1.44 |
| 34-45 | 22.9 | 19.7 | 16.4 | 15.0 | 1.72 |
| -- | -- | -- | -- | -- | -- |
| 78-82 | 21.6 | 18.9 | 16.0 | 15.0 | -- |
| NATIVE GRASS | | | | | |
| 0-6 | 11.1 | 8.4 | 6.5 | 5.1 | 1.49 |
| 6-20 | 15.4 | 12.0 | 9.9 | 8.3 | 1.35 |
| 20-27 | 19.1 | 14.8 | 11.6 | 10.2 | 1.28 |
| 27-40 | 23.4 | 20.0 | 17.1 | 15.4 | 1.33 |
| 40-52 | 20.5 | -- | -- | 11.0 | -- |
| 52-60 | 17.2 | -- | -- | 8.4 | -- |
| 60-72 | 9.2 | -- | -- | 4.6 | -- |
| 72-80 | 13.3 | -- | -- | 6.4 | -- |
| 80-85 | 13.3 | 10.2 | 8.1 | 6.7 | -- |

Table 17.--Atterberg limits for Gomez fine sandy loam.

| Horizon | Liquid limit | Plastic limit | Plasticity index[1] |
|---|---|---|---|
| | | CULTIVATED | |
| Inches | Percent | Percent | |
| 0-8 | 19.5 | 19.5 | (2) |
| 8-13 | 23.3 | 23.3 | (2) |
| 13-24 | 23.0 | 21.1 | 1.9 |
| 24-34 | 25.0 | 21.8 | 3.2 |
| 34-45 | 37.2 | 19.5 | 17.7 |
| | | NATIVE GRASS | |
| 0-6 | 21.4 | 21.4 | (2) |
| 6-20 | 25.8 | 23.1 | 2.7 |
| 20-27 | 32.1 | 25.7 | 6.4 |
| 27-40 | 45.0 | 23.8 | 21.2 |
| 40-52 | 42.2 | 19.5 | 22.7 |
| 52-60 | 32.8 | 16.2 | 16.6 |
| 60-72 | 21.6 | 17.8 | 3.8 |
| 72-80 | 28.2 | 19.1 | 9.1 |
| 80-85 | 28.5 | 16.2 | 12.3 |

[1] See footnote, table 3.
[2] Nonplastic.

Table 18.--Chemical data for Gomez fine sandy loam.

CULTIVATED

| Depth | Extractable ions | | | | C.E.C. | pH | O.M. | $CaCO_3$ equiv. | Free $Fe_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|
| | Na | K | Ca[1] | Mg | | | | | |
| Inches | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | | Per- cent | Per- cent | Per- cent |
| 0-8 | 0.33 | 0.26 | 8.4 | 2.8 | 6.7 | 7.9 | 0.76 | 4.1 | 0.04 |
| 8-13 | .38 | .24 | 9.0 | 2.2 | 6.9 | 7.8 | .66 | 10.0 | .04 |
| 13-24 | .46 | .28 | 9.5 | 2.2 | 8.0 | 7.9 | .50 | 17.1 | -- |
| 24-34 | .64 | .50 | 10.6 | 2.2 | 9.6 | 7.9 | .47 | 25.1 | .07 |
| 34-45 | 1.17 | .73 | 9.8 | 4.8 | 15.4 | 8.2 | .54 | 26.4 | .06 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 78-82 | .90 | .98 | 8.4 | 3.6 | 3.3 | 8.3 | .38 | 44.2 | .03 |

NATIVE GRASS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0-6 | 0.11 | 0.26 | 9.5 | 0.5 | 9.1 | 7.6 | 1.01 | 2.7 | 0.03 |
| 6-20 | .14 | .18 | 11.0 | .7 | 9.6 | 7.6 | .72 | 12.2 | .05 |
| 20-27 | .14 | .18 | 9.8 | 1.3 | 10.6 | 7.7 | .54 | 17.7 | .05 |
| 27-40 | .15 | .34 | 9.8 | 3.7 | 15.9 | 7.6 | .50 | 34.3 | .01 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 80-85 | .11 | .11 | 7.0 | 4.0 | 7.6 | 8.1 | .19 | 13.8 | -- |

[1] Free carbonates present.

Table 19.--Chemical analyses of the clay fraction from Gomez fine sandy loam.

CULTIVATED

| Depth | C.E.C.[1] | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | Weight loss on ignition | $\frac{SiO_2}{R_2O_3}$ |
|---|---|---|---|---|---|---|---|---|
| Inches | Meq./ 100 g. | Per- cent | Per- cent | Per- cent | Per- cent | Per- cent | Per- cent | |
| 0-8 | 52.4 | 25.6 | 3.7 | 2.5 | 24.1 | 4.6 | 11.5 | 8.20 |
| 8-13 | 48.9 | 26.2 | 3.9 | 2.6 | 23.5 | 3.8 | 14.4 | 8.10 |
| 13-24 | 49.5 | 28.0 | 4.5 | 2.7 | 25.0 | 4.6 | 15.5 | 7.80 |
| 24-34 | 55.6 | 30.5 | 3.8 | 2.9 | 23.3 | 6.6 | 19.2 | 9.23 |
| 34-45 | 65.0 | 35.8 | 4.0 | 2.8 | 16.9 | 9.0 | 19.6 | 10.45 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 78-82 | 22.6 | 25.1 | 1.7 | 1.3 | 26.3 | 13.0 | 27.9 | 16.75 |

NATIVE GRASS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0-6 | 54.5 | 27.2 | 3.2 | 3.0 | 20.5 | 3.7 | 11.5 | 9.06 |
| 6-20 | 47.3 | 35.9 | 5.4 | 3.2 | 19.2 | 5.8 | 16.3 | 8.20 |
| 20-27 | 47.7 | 31.5 | 3.2 | 2.8 | 20.9 | 4.1 | 14.6 | 10.70 |
| 27-40 | 46.1 | 32.1 | 2.7 | 2.4 | 21.9 | 7.2 | 21.0 | 13.06 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 80-85 | 64.3 | 22.7 | 1.5 | 2.2 | 25.8 | 6.1 | 18.9 | 13.06 |

[1] Na acetate method on $< 0.2\,\mu$ clay with carbonates and organic matter removed; other analyses on $< 2\,\mu$ clay.

Table 20.--Clay minerals[1] present in Gomez fine sandy loam.

| Cultivated | | | Native grass | | |
|---|---|---|---|---|---|
| Depth | Minerals[2] | | Depth | Minerals | |
| Inches | <0.2μ | 0.2-2μ | Inches | <0.2μ | 0.2-2μ |
| 0-8 | IK | IK (S) | 0-6 | I (S) | IK (S) |
| 8-13 | I/K (M) | IK (W) | 6-20 | IK (M) | IK (S) |
| 13-24 | I/K (M) | I/K (W) | 20-27 | IK (S) | IK (S) |
| 24-34 | /I (VS) | I/K (W) | 27-40 | I/K (M) | IK (M) |
| 34-45 | /I (VS) | IK (VS) | -- | -- | -- |
| -- | -- | -- | 80-85 | I (M) | IK (S) |
| 78-82 | /I (VS) | IK (VS) | | | |

[1] I = illite, K = kaolinite. The most abundant minerals, for both dominant and minor amounts, are indicated first in the sequences. Minor amounts present are indicated after the diagonal; i.e., I/K is illite dominant mineral with a minor amount of kaolite.

Relative intensity of 12.3 Å (when present) is shown in parentheses, as follows:

VS = very strong--most intense peak
S = strong--equal in intensity to other peaks
M = moderate--less intense than other peaks
W = weak--less than 10% of full-scale deflection above background.

[2] The soil of the profile contained clay-sized material that was destroyed during the acid treatment prior to particle size analysis. This material is believed to give the 12.3 Å peak during X-ray analysis.

## Altus Fine Sandy Loam

Altus fine sandy loam is not extensive but is important to agriculture where it occurs in the Rolling Plains of northwestern Texas and western and southwestern Oklahoma. The soil is a deep, moderately sandy, dark Chestnut soil developed in calcareous, moderately sandy old alluvium. It occupies upland flats or drain positions and receives runoff water from the adjacent areas of Miles soils. The Altus soil is fertile and productive when rainfall is adequate; major crops are cotton, grain sorghums, wheat, and oats. Some areas with a relatively shallow water table produce good yields of alfalfa.

Altus is characterized by a dark surface soil and a sandy clay loam subsoil, or B2 horizon. The zone of calcium carbonate accumulation usually is at depths of 3 to 5 feet below the surface. Altus fine sandy loam, which occurs in association with the Miles series, is darker and has a more brownish than reddish subsoil.

## Altus Fine Sandy Loam (native grass)

Location: Two hundred and fifty feet east and 300 feet south of the northwest corner of Section 61, Block 18, H & GN Ry. Co. survey, Hall County, Tex.

A11 — 0 to 8 inches, dark grayish-brown (10YR 4/2) fine sandy loam; very dark brown (10YR 2/2) when moist; weak, granular structure; slightly hard when dry, friable when moist; noncalcareous; contains few thin lenses of loamy sand; clear boundary.

A12 — 8 to 18 inches, dark grayish-brown (10YR 4/2) fine sandy loam; very dark grayish brown (10YR 3/2) when moist; medium, prismatic and weak, fine, subangular blocky structure; hard when dry, friable when moist; many fine pores and wormcasts; noncalcareous; gradual boundary.

B21t — 18 to 26 inches, dark brown (7.5YR 4/2) sandy clay loam; dark brown (7.5YR 3/2) when moist; fine, blocky, and moderate, fine, and medium, subangular blocky structure; very hard when dry, very firm when moist; nearly continuous clay films; many fine pores and a few wormcasts; noncalcareous; gradual boundary.

B22t — 26 to 44 inches, dark brown (7.5YR 4/2) sandy clay loam; dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky and blocky structure; very hard when dry, very firm when moist; continuous thin clay films; few films and threads of $CaCO_3$ mostly on vertical faces of macro peds; soil mass noncalcareous; gradual boundary.

Cca — 44 to 56 inches, strong brown (7.5YR 5/5) fine sandy loam; dark brown (7.5YR 4/4) when moist; weak, subangular blocky structure; very hard when dry, friable when moist; many films and threads of $CaCO_3$; few small $CaCO_3$ concretions; soil mass weakly calcareous.

## Altus Fine Sandy Loam (cultivated)

Location: Three hundred feet east and 300 feet south of the northwest corner of Section 61, Block 18, H & GN Ry. Co. survey, Hall County, Tex.

Ap — 0 to 5 inches, dark grayish-brown (10YR 4/2) fine sandy loam; very dark grayish brown (10YR 3/2) when moist; weak, granular structure to structureless; slightly hard when dry, very friable when moist; noncalcareous; contains few thin lenses of more sandy materials; abrupt boundary.

A1 — 5 to 20 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; very dark brown (10YR 2/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; many fine pores and wormcasts; noncalcareous; gradual boundary.

B21t — 20 to 32 inches, brown (7.5YR 4/3) sandy clay loam; dark brown (7.5YR 3/3) when moist; fine, blocky, and moderate, fine, and medium subangular blocky structure; very hard when dry, very firm when moist; thin continuous clay films; noncalcareous; clear boundary.

B23t — 32 to 48 inches, grayish-brown (10YR 5/2) clay loam; dark grayish brown (10YR 4/2) when moist; many fine, faint yellowish-brown mottles; weak to moderate, fine, blocky and subangular blocky structure; very hard when dry, firm when moist; few films and threads of $CaCO_3$; few small $CaCO_3$ concretions; soil mass strongly calcareous; gradual boundary.

Cca — 48 to 60 inches, reddish-brown (5YR 5/4) sandy clay loam; reddish brown (5YR 4/4) when moist; few yellowish-brown mottles; many films and threads of $CaCO_3$; soil mass weakly calcareous.

Note: A few small water-rounded quartz pebbles are throughout the profile.

Table 21.--Mechanical analyses of Altus fine sandy loam.

CULTIVATED

| Depth | Sand | Silt | Clay | Textural class |
|---|---|---|---|---|
| Inches | Percent | Percent | Percent | |
| 0-5 | 66.0 | 18.9 | 15.1 | Fine sandy loam. |
| 5-20 | 65.8 | 16.3 | 17.9 | Do. |
| 20-32 | 61.7 | 15.7 | 22.6 | Sandy clay loam. |
| 32-48 | 58.0 | 16.0 | 26.0 | Sandy clay loam.[1] |
| 48-60 | 60.0 | 16.0 | 24.0 | Do. |
| -- | -- | -- | -- | -- |
| 75-80 | 70.0 | 10.0 | 20.0 | Sandy clay loam.[1] |

NATIVE GRASS

| | | | | |
|---|---|---|---|---|
| 0-8 | 72.4 | 14.7 | 12.9 | Fine sandy loam. |
| 8-18 | 66.4 | 14.4 | 19.2 | Do. |
| 18-26 | 61.4 | 16.9 | 21.7 | Sandy clay loam. |
| 26-44 | 62.8 | 15.2 | 22.0 | Do. |
| 44-56 | 45.2 | 26.8 | 28.0 | Sandy clay loam.[1] |
| 56-69 | 48.0 | 24.0 | 28.0 | Do. |
| -- | -- | -- | -- | -- |
| 75-80 | 56.0 | 24.0 | 20.0 | Sandy clay loam.[1] |

[1] Because appreciable quantities of $CaCO_3$ were present in this horizon, a hydrometer analysis was used to determine particle-size distribution.

Table 22.--Soil-moisture relationships for Altus fine sandy loam.

CULTIVATED

| Depth | Soil-moisture tension for-- | | | | Bulk density |
|---|---|---|---|---|---|
| | 1/3 bar | 1 bar | 5 bars | 15 bars | |
| Inches | ---------Percent moisture by weight--------- | | | | G./cc. |
| 0-5 | 15.7 | 10.2 | 7.3 | 6.2 | 1.63 |
| 5-20 | 18.5 | 13.5 | 10.2 | 8.4 | 1.48 |
| 20-32 | 20.9 | 15.3 | 11.7 | 9.7 | 1.66 |
| 32-48 | 17.8 | 13.1 | 9.8 | 8.0 | 1.69 |
| 48-60 | 19.8 | 14.2 | 10.6 | 8.6 | 1.73 |
| 60-69 | 15.6 | -- | -- | 7.0 | 1.68 |
| -- | -- | -- | -- | -- | -- |
| 75-80 | 14.6 | 9.8 | 7.5 | 5.6 | -- |

NATIVE GRASS

| | | | | | |
|---|---|---|---|---|---|
| 0-8 | 13.4 | 9.2 | 6.6 | 5.4 | 1.39 |
| 8-18 | 16.8 | 12.4 | 9.5 | 8.0 | 1.43 |
| 18-26 | 19.8 | 14.5 | 11.0 | 9.1 | 1.54 |
| 26-44 | 20.6 | 14.9 | 11.3 | 9.2 | 1.62 |
| 44-56 | 24.2 | 17.8 | 13.5 | 11.1 | 1.68 |
| 56-69 | 16.6 | -- | -- | 7.6 | 1.78 |
| -- | -- | -- | -- | -- | -- |
| 75-80 | 15.7 | 10.5 | 7.6 | 6.1 | -- |

Table 23.--Atterberg limits for Altus fine sandy loam.

| Horizon | Liquid limit | Plastic limit | Plasticity index[1] |
|---|---|---|---|
| | CULTIVATED | | |
| Inches | Percent | Percent | |
| 0-5 | 19.9 | 16.6 | 3.3 |
| 5-20 | 23.7 | 16.2 | 7.5 |
| 20-32 | 26.3 | 16.3 | 10.0 |
| 32-48 | 24.0 | 15.5 | 8.5 |
| 48-60 | 19.4 | 14.8 | 4.6 |
| 60-69 | 21.4 | 14.1 | 7.3 |
| | NATIVE GRASS | | |
| 0-8 | 18.0 | 15.7 | 2.3 |
| 8-18 | 19.1 | 14.7 | 4.4 |
| 18-26 | 25.4 | 16.0 | 9.4 |
| 26-35 | 23.5 | 17.8 | 5.7 |
| 35-44 | 22.1 | 16.7 | 5.4 |
| 44-56 | 21.4 | 17.0 | 4.4 |
| 56-69 | 23.6 | 16.0 | 7.6 |

[1] See footnote, table 3.

Table 24.--Chemical data for Altus fine sandy loam.

CULTIVATED

| Depth | Extractable ions | | | | C.E.C. | pH | O.M. | $CaCO_3$ equiv. | Free $Fe_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|
| | Na | K | Ca | Mg | | | | | |
| Inches | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | | Per- cent | Per- cent | Per- cent |
| 0-5 | 0.10 | 0.30 | 9.3 | 1.3 | 11.7 | 7.0 | 1.13 | -- | 0.15 |
| 5-20 | .12 | .17 | 11.1 | 2.8 | 17.6 | 6.7 | 1.07 | -- | .14 |
| 20-32 | .19 | .15 | 13.5 | 3.0 | 20.4 | 6.8 | .66 | -- | .24 |
| 32-48 | .19 | .12 | 13.5 | 2.6 | 16.5 | 7.5 | .32 | 1.6 | .12 |
| 48-60 | .19 | .13 | 14.1 | 3.1 | 18.5 | 7.5 | .22 | 3.0 | .15 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 75-80 | .16 | .39 | 10.0 | 2.6 | 11.7 | 7.5 | .06 | 2.0 | .08 |

NATIVE GRASS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0-8 | 0.09 | 0.33 | 9.0 | 1.5 | 10.9 | 6.5 | 1.67 | -- | 0.26 |
| 8-18 | .16 | .24 | 12.5 | 2.6 | 17.8 | 7.1 | 1.07 | -- | .21 |
| 18-26 | .24 | .15 | 14.1 | 3.3 | 20.4 | 7.2 | .98 | -- | .19 |
| 26-44 | .22 | .15 | 14.6 | 2.8 | 15.2 | 7.5 | .59 | 1.9 | .18 |
| 44-56 | .30 | .17 | 15.5 | 3.7 | 18.7 | 7.6 | .19 | 3.8 | .21 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 75-80 | .24 | .10 | 8.9 | 2.8 | 12.6 | 7.4 | .13 | 1.5 | .23 |

Table 25.--Chemical analyses of the clay fraction from Altus fine sandy loam.

CULTIVATED

| Depth | C.E.C.[1] | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | Weight loss on ignition | $\frac{SiO_2}{R_2O_3}$ |
|---|---|---|---|---|---|---|---|
| Inches | Meq./ 100 g. | Percent | Percent | Percent | Percent | Percent | |
| 0-5 | 86.2 | 33.4 | 10.9 | 4.1 | 17.2 | 10.4 | 4.19 |
| 5-20 | 91.4 | 43.6 | 9.5 | 3.3 | 9.2 | 12.8 | 6.37 |
| 20-32 | 94.6 | 46.8 | 10.7 | 3.2 | 4.9 | -- | 6.25 |
| 32-48 | 92.8 | 36.9 | 14.8 | 5.8 | 10.5 | 9.3 | 3.38 |
| 48-60 | 94.2 | 40.8 | 15.6 | 5.0 | 11.9 | 10.5 | 3.68 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 75-80 | 97.0 | 36.5 | 13.1 | 5.8 | 13.8 | 9.2 | 3.68 |

NATIVE GRASS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0-8 | 78.1 | 29.7 | 11.6 | 2.8 | 16.3 | 13.3 | 3.76 |
| 8-18 | 92.4 | 33.6 | 13.8 | 6.0 | 12.1 | 11.7 | 3.23 |
| 18-26 | 92.9 | 37.5 | 13.7 | 5.4 | 10.8 | 12.1 | 3.71 |
| 26-44 | 100.2 | 38.7 | 15.7 | 5.1 | 11.0 | 10.5 | 3.46 |
| 44-56 | 95.6 | 41.3 | 18.3 | 4.7 | 11.1 | 9.6 | 3.29 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 75-80 | 89.1 | 38.3 | 13.2 | .6.2 | 11.0 | 9.5 | 3.79 |

[1] Na acetate method on $< 0.2\mu$ clay with carbonates and organic matter removed; other analyses on $< 2\mu$ clay.

Table 26.--Clay minerals[1] present in Altus fine sandy loam.

| Cultivated | | | Native grass | | |
|---|---|---|---|---|---|
| Depth | Minerals | | Depth | Minerals | |
| Inches | <0.2μ | 0.2-2μ | Inches | < 0.2μ | 0.2-2μ |
| 0-5 | MI | IKM | 0-8 | M/I | IKM |
| 5-20 | MI/K | IKM | 8-18 | MI/K | IKM |
| 20-32 | MI/K | IKM | 18-26 | MI/K | IKM |
| 32-48 | M/IK | MKI | 26-44 | M/IK | MKI |
| 48-60 | MI/K | MKI | 44-56 | M/I | IKM |
| -- | -- | -- | -- | -- | -- |
| 75-80 | MI/K | MKI | 75-80 | MI | MIK |

[1] I = illite, K = kaolinite, M = montmorillonite. The most abundant minerals, for both dominant and minor amounts, are indicated first in the sequences. Minor amounts present are indicated after the diagonal; e.g., M/I is montmorillonite dominant mineral with a minor amount of illite.

## Miles Fine Sandy Loam

Miles fine sandy loam is a Reddish Chestnut soil developed from moderately sandy, calcareous sediments in the Rolling Plains of western Texas and Oklahoma. Parent materials are mostly plains outwash or old alluvium of Quaternary and Pliocene age but occasionally are similar materials of other formations or modes of accumulation. These soils are quite similar to the Amarillo series which occurs on the southern High Plains.

Miles fine sandy loam has a brown or dark brown to reddish-brown surface horizon of fine sandy loam with a reddish-brown sandy clay loam subsoil, or B2t horizon. A zone of $CaCO_3$ accumulation is normally present at 4 to 6 or more feet below the surface.

Profiles sampled are representative.

### Miles Fine Sandy Loam (native grass)

Location: 0.6 mile north, 0.1 mile east, and 100 feet north of southwest corner of Section 4, Block L, Gunter and Munson survey, Hall County, Tex.

A1 0 to 6 inches, dark brown (7.5YR 4/2) fine sandy loam; dark brown (7.5YR 3/2) when moist; weak, granular structure;

soft when dry, very friable when moist; noncalcareous; gradual boundary.

B21t 6 to 16 inches, dark brown (7.5YR 3/2) sandy clay loam; dark brown (7.5YR 2/2) when moist; moderate, very coarse prismatic and weak, fine, subangular blocky structure; thin discontinuous clay films on prism faces; very hard when dry, friable when moist; many fine and medium pores; many wormcasts; noncalcareous; gradual boundary.

B22t 16 to 23 inches, reddish-brown (5YR 4/3) sandy clay loam; dark reddish brown (5YR 3/3) when moist; moderate, very coarse prismatic and fine, subangular blocky structure; thin discontinuous clay films on prism faces; very hard when dry, friable to firm when moist; many fine and medium pores; many wormcasts; noncalcareous; gradual boundary.

B23t 23 to 32 inches, reddish-brown (5YR 4/4) sandy clay loam; dark reddish brown (5YR 3/4) when moist; moderate, very coarse prismatic and fine, subangular blocky structure; thin discontinuous clay films on prism faces; very hard when dry, firm when moist; many fine pores and a few wormcasts; noncalcareous; gradual boundary.

B3 32 to 50 inches, yellowish-red (5YR 4/6) heavy fine sandy loam; yellowish red (5YR 3/6) when moist; weak, fine, subangular blocky structure; hard when dry, friable when moist; noncalcareous; gradual boundary.

Cca 50 to 62 inches, yellowish-red (5YR 5/6) fine sandy loam; yellowish red (5YR 4/6) when moist; many threads and films of $CaCO_3$; soil mass weakly calcareous.

## Miles Fine Sandy Loam (cultivated)

Location: 0.6 mile north, 0.1 mile east, and 100 feet south of southwest corner of Section 4, Block L, Gunter and Munson survey, Hall County, Tex.

Ap 0 to 6 inches, dark brown (7.5YR 4/2) fine sandy loam; dark brown (7.5YR 3/2) when moist; weak granular structure; soft when dry, very friable when moist; noncalcareous; abrupt boundary.

B21t 6 to 24 inches, reddish-brown (5YR 4/3) sandy clay loam; dark reddish brown (5YR 3/3) when moist; weak to moderate very coarse prismatic and fine subangular blocky structure; thin discontinuous clay films on prism faces; very

hard when dry, friable when moist; many fine pores and wormcasts; noncalcareous; diffuse boundary.

B22t 24 to 36 inches, reddish-brown (5YR 4/3) sandy clay loam; dark reddish brown (5YR 3/4) when moist; moderate, very coarse prismatic and fine, subangular blocky structure; very hard when dry, friable when moist; many fine pores and a few wormcasts; noncalcareous; gradual boundary.

B3 36 to 48 inches, yellowish-red (5YR 4/6) sandy clay loam; yellowish red (5YR 3/6) when moist; weak, fine, subangular blocky structure; hard when dry, friable when moist; noncalcareous; gradual boundary.

Cca 48 to 75 inches, yellowish-red (5YR 5/6) fine sandy loam; yellowish red (5YR 4/6) when moist; friable when moist; common threads and films of $CaCO_3$; soil mass weakly calcareous; gradual boundary.

C 75 to 84 inches, reddish-yellow (5YR 6/6) loamy fine sand; yellowish red (5YR 4/6) when moist; very friable when moist; very weakly calcareous.

Note: A very few small water-rounded quartz pebbles are throughout the profile.

Table 27.--Mechanical analyses of Miles fine sandy loam.

CULTIVATED

| Depth | Sand | Silt | Clay | Textural class |
|---|---|---|---|---|
| Inches | Percent | Percent | Percent | |
| 0-4 | 82.3 | 8.4 | 9.3 | Loamy fine sand. |
| 4-6 | 71.6 | 12.4 | 16.0 | Fine sandy loam. |
| 6-24 | 64.4 | 13.3 | 22.3 | Sandy clay loam. |
| 24-36 | 61.1 | 13.4 | 25.5 | Sandy clay loam. |
| 36-48 | 72.1 | 2.6 | 25.3 | Sandy clay loam. |
| 48-64 | 76.1 | 6.9 | 17.0 | Fine sandy loam. |
| 64-75 | 81.8 | 5.0 | 13.2 | Fine sandy loam. |
| -- | -- | -- | -- | -- |
| 96-100 | 56.0 | 24.8 | 19.2 | Fine sandy loam.[1] |
| | | NATIVE GRASS | | |
| 0-6 | 75.1 | 13.4 | 11.5 | Fine sandy loam. |
| 6-23 | 67.5 | 10.2 | 22.3 | Sandy clay loam. |
| 23-32 | 63.1 | 10.4 | 26.5 | Sandy clay loam. |
| 32-50 | 72.6 | 8.5 | 18.9 | Fine sandy loam. |
| 50-62 | 79.0 | 5.7 | 15.3 | Fine sandy loam. |
| 62-75 | 82.4 | 5.1 | 12.5 | Fine sandy loam. |

[1] Because appreciable quantities of $CaCO_3$ were present in this horizon, a hydrometer analysis was used to determine particle-size distribution.

Table 28.--Soil-moisture relationships for Miles fine sandy loam.

CULTIVATED

| Depth | Soil-moisture tension for-- | | | | Bulk density |
|---|---|---|---|---|---|
| | 1/3 bar | 1 bar | 5 bars | 15 bars | |
| Inches | ---------Percent moisture by weight--------- | | | | G./cc. |
| 0-4 | 9.8 | 6.1 | 4.4 | 3.8 | 1.40 |
| 4-6 | 15.6 | 10.2 | 8.1 | 6.7 | 1.42 |
| 6-24 | 20.1 | 14.0 | 11.7 | 9.4 | 1.47 |
| 24-36 | 20.8 | 14.9 | 12.4 | 10.4 | 1.48 |
| 36-48 | 18.6 | 12.9 | 10.4 | 8.6 | 1.56 |
| 48-64 | 15.0 | -- | -- | 7.0 | 1.71 |
| 64-75 | 11.4 | -- | -- | 5.3 | 1.80 |
| -- | -- | -- | -- | -- | -- |
| 96-100 | 18.9 | 12.8 | 9.5 | 7.4 | -- |
| | NATIVE GRASS | | | | |
| 0-6 | 13.0 | 7.8 | 6.1 | 4.8 | 1.36 |
| 6-23 | 18.2 | 12.9 | 10.6 | 8.8 | 1.40 |
| 23-32 | 20.1 | 14.2 | 11.9 | 9.8 | 1.43 |
| 32-50 | 16.2 | 11.4 | 9.2 | 7.7 | 1.54 |
| 50-62 | 12.8 | -- | -- | 6.2 | 1.69 |
| 62-75 | 10.5 | -- | -- | 5.0 | 1.75 |
| -- | -- | -- | -- | -- | -- |
| 94-100 | 11.0 | 6.6 | 4.0 | 2.9 | -- |

Table 29.--Atterberg limits for Miles fine sandy loam.

CULTIVATED

| Horizon | Liquid limit | Plastic limit | Plasticity index[1] |
|---|---|---|---|
| Inches | Percent | Percent | |
| 0-4 | -- | -- | -- |
| 4-6 | 16.7 | 15.2 | 1.5 |
| 6-10 | 17.7 | 16.1 | 1.6 |
| 10-24 | 22.0 | 16.4 | 5.6 |
| 24-36 | 24.5 | 15.2 | 9.3 |
| 36-48 | 24.1 | 16.0 | 8.1 |
| 48-64 | 21.3 | 15.7 | 5.6 |
| 64-75 | 19.1 | 15.8 | 3.3 |
| NATIVE GRASS | | | |
| 0-6 | 18.2 | 18.0 | 0.2 |
| 6-15 | 19.2 | 17.5 | 1.7 |
| 15-23 | 24.0 | 16.9 | 7.1 |
| 23-32 | 25.6 | 17.2 | 8.4 |
| 32-41 | 21.9 | 17.1 | 4.8 |
| 41-50 | 20.7 | 16.9 | 3.8 |
| 50-62 | 17.7 | 16.0 | 1.7 |
| 62-75 | 17.2 | 16.4 | .8 |

[1] See footnote, table 3.

Table 30.--Chemical data for Miles fine sandy loam.

CULTIVATED

| Depth | Extractable ions | | | | C.E.C. | pH | O.M. | $CaCO_3$ equiv. | Free $Fe_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|
| | Na | K | Ca | Mg | | | | | |
| Inches | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | | Per- cent | Per- cent | Per- cent |
| 0-4 | 0.05 | 0.53 | 6.5 | 0.7 | 8.0 | 6.9 | 0.63 | -- | 0.28 |
| 4-6 | .06 | .61 | 8.1 | 2.2 | 10.9 | 6.7 | .88 | -- | .34 |
| 6-24 | .08 | .53 | 9.4 | 3.3 | 13.5 | 6.1 | .76 | -- | .34 |
| 24-36 | .09 | .56 | 9.6 | 3.7 | 14.7 | 6.3 | .54 | -- | .33 |
| 36-48 | .10 | .45 | 9.5 | 4.1 | 13.2 | 7.0 | .41 | -- | .33 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 96-100 | .25 | .03 | 19.8 | 4.2 | 14.8 | 7.6 | .19 | 7.6 | .31 |
| NATIVE GRASS | | | | | | | | | |
| 0-6 | 0.07 | 0.67 | 10.3 | 0.9 | 11.3 | 7.1 | 1.23 | -- | 0.10 |
| 6-23 | .07 | .65 | 9.9 | 3.7 | 13.5 | 6.7 | 1.01 | -- | .26 |
| 23-32 | .14 | .64 | 9.8 | 3.1 | 14.1 | 6.5 | .76 | -- | .28 |
| 32-50 | .12 | .41 | 7.6 | 3.2 | 11.3 | 6.5 | .38 | -- | .29 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 94-100 | .13 | .13 | 21.2 | 1.3 | 6.5 | 7.7 | .09 | 18.2 | .36 |

Table 31.--Chemical analyses of the clay fraction from Miles fine sandy loam.

CULTIVATED

| Depth | C.E.C.[1] | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | Weight loss on ignition | $\frac{SiO_2}{R_2O_3}$ |
|---|---|---|---|---|---|---|---|
| Inches | Meq./ 100 g. | Percent | Percent | Percent | Percent | Percent | |
| 0-4 | 82.4 | 22.5 | 8.8 | 8.2 | 19.1 | 11.4 | 2.72 |
| 4-6 | 70.4 | 32.3 | 9.4 | 6.6 | 13.5 | 11.0 | 4.05 |
| 6-24 | 69.7 | 39.4 | 17.0 | 7.4 | 10.4 | 9.3 | 3.08 |
| 24-36 | 73.3 | 39.0 | 16.7 | 4.6 | 10.6 | 9.4 | 3.37 |
| 36-48 | 78.3 | 37.8 | 17.3 | 8.1 | 11.7 | 8.9 | 2.85 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 96-100 | 82.8 | 34.2 | 13.9 | 4.8 | 13.3 | 7.5 | 3.42 |
| | | | NATIVE GRASS | | | | |
| 0-6 | 63.1 | 24.7 | 13.9 | 1.9 | 18.3 | 10.9 | 2.77 |
| 6-23 | 61.1 | 31.6 | 17.9 | 6.8 | 12.1 | 12.0 | 2.41 |
| 23-32 | 58.9 | 37.5 | 19.1 | 5.6 | 9.3 | 10.6 | 2.81 |
| 32-50 | 83.6 | 31.2 | 16.2 | 5.3 | 10.3 | 9.8 | 2.72 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 94-100 | 105.3 | 19.1 | 8.2 | 2.4 | 13.0 | 9.3 | 3.33 |

[1] Na acetate method on $< 0.2\mu$ clay with carbonates and organic matter removed; other analyses on $< 2\mu$ clay.

Table 32.--Clay minerals[1] present in Miles fine sandy loam.

| Cultivated | | | Native grass | | |
|---|---|---|---|---|---|
| Depth | Minerals | | Depth | Minerals | |
| Inches | < 0.2μ | 0.2-2μ | Inches | < 0.2μ | 0.2-2μ |
| 0-4 | MI/K | IKV | 0-6 | IM | IK/MV |
| 4-6 | M/IK | IKV | 6-23 | MI | IK/M |
| 6-24 | MI | IK/M | 23-32 | IM | IK/M |
| 24-36 | I/K | IK/M | 32-50 | IM | IK/M |
| 36-48 | MI | IK/M | -- | -- | -- |
| -- | -- | -- | 94-100 | M/I | M/IK |
| 96-100 | M/I | MKI | | | |

[1] I = illite, K = kaolinite, M = montmorillonite, V = vermiculite. The most abundant minerals, for both dominant and minor amounts, are indicated first in the sequences. Minor amounts present are indicated after the diagonal; e.g., MI/K is montmorillonite and illite dominant mineral with a minor amount of kaolinite.

Table 33.--Mineralogy of the heavy and light mineral suites of Miles fine sandy loam (native grass).

HEAVY (SP.GR. > 2.95)

| Mineral[1] | Depth (inches) | | | | |
|---|---|---|---|---|---|
| | 0-6 | 6-23 | 23-32 | 32-50 | 94-100 |
| | Percent | Percent | Percent | Percent | Percent |
| Opaque | 66.9 | 67.8 | 61.5 | 64.0 | 63.3 |
| Garnet | 3.1 | 3.3 | 2.1 | 4.0 | 2.0 |
| Epidote[2] | 6.5 | 6.4 | 6.2 | 6.0 | 3.8 |
| Amphibole | 1.9 | .8 | 3.2 | .9 | 2.8 |
| Pyroxene | .6 | .5 | .2 | .9 | 2.0 |
| Zircon | 13.6 | 11.8 | 18.5 | 11.3 | 16.3 |
| Tourmaline | 4.2 | 5.1 | 6.2 | 8.9 | 6.2 |
| Others | 3.2 | 4.3 | 2.1 | 4.0 | 3.6 |
| Zircon/tourmaline | 3.25 | 2.35 | 3.00 | 1.26 | 2.61 |

See footnotes at end of table.

Table 33.--Mineralogy of the heavy and light mineral suites of Miles fine sandy loam (native grass)--Continued

LIGHT (SP.GR. < 2.95)

| Mineral[1] | Depth (inches) | | | | |
|---|---|---|---|---|---|
| | 0-6 | 6-23 | 23-32 | 32-50 | 94-100 |
| | Percent | Percent | Percent | Percent | Percent |
| Quartz | 77.1 | 83.4 | 81.1 | 83.6 | 70.3 |
| Orthoclase | 21.5 | 15.3 | 18.4 | 16.2 | 23.5 |
| Microcline | 1.0 | 1.3 | .5 | .2 | 1.2 |
| Micas | 0 | 0 | 0 | 0 | 4.2 |
| Others | .4 | 0 | 0 | 0 | .8 |

[1] Calculated for each horizon as percent of the total number of particles of the heavy or light mineral suite.
[2] Includes zoisite.

## Pratt Fine Sandy Loam[4]

Pratt fine sandy loam is a moderately dark sandy Chestnut soil occurring extensively in northwestern Oklahoma and adjoining areas of Texas and Kansas. It has a neutral to slightly acid surface layer and alkaline lower layers but commonly does not have free calcium carbonates in any part of the solum. It is developed in sandy or moderately sandy aeolian mantles. The soil is moderately productive and much of it is cultivated to wheat and sorghum. The usual associated soil is Tivoli which is more sandy and less dark.

The subsoil of Pratt ranges from a loamy fine sand to a loam.

### Pratt Fine Sandy Loam (native grass)

Location: One thousand three hundred and thirty feet north and 230 feet west of the southwest corner of Section 35, T. 23 N., R. 21 W., on the Southern Great Plains Field Station, Woodward County, Okla.

All 0 to 12 inches, dark brown (7.5YR 4/2) fine sandy loam; dark brown (7.5YR 3/2) when moist; moderate, medium, and fine

[4] Profile descriptions written by Joe Nichols, Soil Scientist, SCS, Woodward, Okla.

granular structure; friable when moist; noncalcareous; many grass roots; gradual boundary.

A12 — 12 to 27 inches, dark brown (7.5YR 4/2) loamy fine sand; dark brown (7.5YR 3/2) when moist; weak to moderate, medium and fine granular structure; friable when moist; noncalcareous; gradual boundary.

B2t — 27 to 40 inches, reddish-brown (5YR 4/3) fine sandy loam; dark reddish brown (5YR 3/3) when moist; moderate, medium, granular structure; friable when moist, slightly sticky when wet; noncalcareous; gradual boundary.

IIC1 — 40 to 48 inches, reddish-yellow (5YR 6/6) clay loam; yellowish red (5YR 4/6) when moist; moderate, medium, granular structure; firm when moist, sticky when wet; calcareous; gradual boundary.

IIC2 — 48+ inches, reddish-yellow (5YR 6/6) clay loam; slightly lighter and darker mottles; massive; firm when moist, sticky when wet; calcareous.

Note: This soil is formed in a relatively thin mantle of moderately sandy material over redbeds. The layers below 40 inches appear to be redbeds. The B2t horizon probably is formed in a mixture of the aeolian mantle and redbed materials. Horizons IIC1 and IIC2 are not modal for Pratt.

## Pratt Fine Sandy Loam (cultivated)

Location: Sixteen hundred seventy-five feet north and 760 feet east of the southwest corner of Section 36, T. 23 N., R. 21 W., on the Southern Great Plains Field Station, Woodward County, Okla.

Ap — 0 to 7 inches, dark grayish-brown (10YR 4/2) loamy fine sand; very dark grayish brown (10YR 3/2) when moist; weak granular structure; soft when dry, very friable when moist, nonsticky when wet; noncalcareous, clear boundary.

A1 — 7 to 12 inches, dark grayish-brown (10YR 4/2) fine sandy loam; very dark grayish brown (10YR 3/2) when moist; weak to moderate fine and medium granular structure; hard when dry, friable when moist; noncalcareous; gradual boundary.

B2t — 12 to 32 inches, dark brown (7.5YR 4/2) loamy fine sand; dark brown (7.5YR 3/2) when moist; moderate, medium, and fine granular structure; slightly hard when dry, friable when moist, slightly sticky when wet; noncalcareous; gradual boundary.

C — 32 to 42 inches, reddish-yellow (5YR 6/6) loamy fine sand; yellowish red (5YR 5/6) when moist; massive; hard when dry, friable when moist, slightly sticky when wet; noncalcareous.

Table 34.--Mechanical analyses of Pratt fine sandy loam.

CULTIVATED

| Depth | Sand | Silt | Clay | Textural class |
|---|---|---|---|---|
| Inches | Percent | Percent | Percent | |
| 0-4 | 85.3 | 9.3 | 5.4 | Loamy fine sand. |
| 4-7 | 84.0 | 12.9 | 3.1 | Do. |
| 7-10 | 79.8 | 10.9 | 9.3 | Fine sandy loam. |
| 10-12 | 79.1 | 10.1 | 10.8 | Do. |
| 12-18 | 80.2 | 9.4 | 10.4 | Do. |
| 18-25 | 81.6 | 8.3 | 10.1 | Loamy fine sand. |
| 25-32 | 87.5 | 9.4 | 3.1 | Do. |
| 32-44 | 85.1 | 10.4 | 4.5 | Do. |
| 44-56 | 85.2 | 8.6 | 6.2 | Do. |
| 56-68 | 87.5 | 5.6 | 6.9 | Do. |
| -- | -- | -- | -- | -- |
| 80-84 | 82.2 | 8.8 | 9.0 | Loamy fine sand. |
| NATIVE GRASS | | | | |
| 0-6 | 73.7 | 16.4 | 9.9 | Fine sandy loam. |
| 6-12 | 79.7 | 13.1 | 7.2 | Loamy fine sand. |
| 12-18 | 79.4 | 12.7 | 7.9 | Do. |
| 18-27 | 80.8 | 11.7 | 7.5 | Do. |
| 27-40 | 73.2 | 15.9 | 10.9 | Fine sandy loam. |
| 40-48 | 28.0 | 40.0 | 32.0 | Clay loam.[1] |
| 48-56 | 32.8 | 41.2 | 26.0 | Loam.[1] |
| 56-68 | 32.0 | 44.0 | 24.0 | Do. |
| -- | -- | -- | -- | -- |
| 77-80 | 41.8 | 48.0 | 10.2 | Loam.[1] |

[1] Because appreciable quantities of $CaCO_3$ were present in this horizon, a hydrometer analysis was used to determine particle-size distribution.

Table 35.--Soil-moisture relationships for Pratt fine sandy loam.

CULTIVATED

| Depth | Soil-moisture tension for-- | | | | Bulk density |
|---|---|---|---|---|---|
| | 1/3 bar | 1 bar | 5 bars | 15 bars | |
| Inches | ---------Percent moisture by weight--------- | | | | G./cc. |
| 0-4 | 8.7 | 5.4 | 3.1 | 2.6 | 1.56 |
| 4-7 | 9.1 | 5.5 | 3.4 | 2.9 | 1.64 |
| 7-10 | 14.2 | 9.6 | 6.3 | 5.0 | 1.70 |
| 10-12 | 14.6 | 9.7 | 6.7 | 5.7 | 1.61 |
| 12-18 | 12.0 | 8.6 | 5.8 | 5.1 | 1.48 |
| 18-25 | 12.1 | 8.4 | 6.1 | 4.8 | 1.55 |
| 25-32 | 11.3 | 8.2 | 5.7 | 4.8 | 1.55 |
| 32-44 | 13.8 | 10.3 | 6.8 | 5.6 | 1.66 |
| 44-56 | 11.4 | -- | -- | 5.1 | 1.80 |
| 56-68 | 9.4 | -- | -- | 4.0 | 1.82 |
| -- | -- | -- | -- | -- | -- |
| 80-84 | 14.6 | 9.5 | 6.4 | 4.8 | -- |

NATIVE GRASS

| | | | | | |
|---|---|---|---|---|---|
| 0-6 | 13.9 | 10.0 | 6.6 | 5.6 | 1.42 |
| 6-12 | 10.2 | 7.4 | 5.1 | 4.4 | 1.42 |
| 12-18 | 10.3 | 8.1 | 5.4 | 4.6 | 1.36 |
| 18-27 | 9.6 | 7.4 | 5.0 | 4.4 | 1.36 |
| 27-40 | 13.5 | 9.8 | 6.7 | 5.7 | 1.35 |
| 40-48 | 21.1 | 17.8 | 12.4 | 9.4 | 1.43 |
| 48-56 | 17.2 | -- | -- | 5.1 | 1.56 |
| 56-68 | 18.0 | -- | -- | 4.0 | 1.67 |
| -- | -- | -- | -- | -- | -- |
| 77-80 | 11.5 | 8.8 | 4.4 | 3.4 | -- |

Table 36.--Atterberg limits for Pratt fine sandy loam.

CULTIVATED

| Horizon | Liquid limit | Plastic limit | Plasticity index[1] |
|---|---|---|---|
| Inches | Percent | Percent | |
| 0-4 | 13.8 | 13.2 | 0.6 |
| -- | -- | -- | -- |
| 7-12 | 17.7 | 15.2 | 2.5 |
| 12-18 | 17.8 | 15.2 | 2.6 |
| 18-32 | 17.8 | 14.6 | 3.2 |
| 32-44 | 18.9 | 14.8 | 4.1 |
| 44-56 | 16.9 | 15.1 | 1.8 |
| 56-68 | 15.9 | 15.2 | 0.7 |
| NATIVE GRASS | | | |
| 0-12 | 20.2 | 17.8 | 2.4 |
| 12-27 | 18.0 | 15.8 | 2.2 |
| 27-40 | 19.0 | 16.2 | 2.8 |
| 40-48 | 22.6 | 17.6 | 5.0 |
| 48-56 | 23.1 | 17.8 | 5.3 |
| 56-68 | 25.5 | 18.0 | 7.5 |

[1] See footnote, table 3.

Table 37.--Chemical data for Pratt fine sandy loam.

CULTIVATED

| Depth | Extractable ions | | | | C.E.C. | pH | O.M. | $CaCO_3$ equiv. | Free $Fe_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|
| | Na | K | Ca | Mg | | | | | |
| Inches | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | | Per- cent | Per- cent | Per- cent |
| 0-4 | 0.07 | 0.28 | 4.3 | 0.5 | 4.8 | 7.0 | 0.50 | -- | 0.12 |
| 4-7 | .07 | .12 | 5.0 | .6 | 4.7 | 6.4 | .63 | -- | .15 |
| 7-10 | .10 | .25 | 5.6 | 1.6 | 7.6 | 6.2 | .94 | -- | .08 |
| 10-12 | .10 | .21 | 6.0 | 2.0 | 7.4 | 6.1 | .98 | -- | .11 |
| 12-18 | .10 | .17 | 5.6 | 1.6 | 7.1 | 6.1 | .85 | -- | .13 |
| 18-25 | .09 | .23 | 5.0 | 1.8 | 7.1 | 6.1 | .66 | -- | .14 |
| 25-32 | .11 | .23 | 5.0 | 1.5 | 6.5 | 6.0 | .47 | -- | .20 |
| 32-42 | .10 | .31 | 6.2 | 1.7 | 7.8 | 6.1 | .38 | -- | .18 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 80-84 | .10 | .21 | 5.3 | 2.2 | 10.7 | 6.3 | .13 | -- | .12 |
| | | | | NATIVE GRASS | | | | | |
| 0-6 | 0.09 | 1.36 | 6.9 | 2.0 | 14.6 | 6.8 | 2.24 | -- | 0.18 |
| 6-12 | .09 | .42 | 5.9 | 1.7 | 10.7 | 6.6 | 1.32 | -- | .18 |
| 12-18 | .11 | .23 | 6.7 | 2.0 | 11.1 | 6.7 | 1.07 | -- | .18 |
| 18-27 | .07 | .23 | 6.0 | 1.9 | 10.0 | 6.5 | .98 | -- | .15 |
| 27-40 | .15 | .26 | [1] 21.3 | 1.6 | 13.0 | 7.5 | .94 | 2.4 | .16 |
| 40-48 | .16 | .16 | [1] 22.5 | 2.0 | 12.6 | 7.5 | .79 | 28.1 | .14 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 77-80 | .41 | .12 | [1] 15.0 | 2.0 | 5.0 | 7.8 | .32 | 9.2 | .17 |

[1] Free carbonates present.

Table 38.--Chemical analyses of the clay fraction from Pratt fine sandy loam.

CULTIVATED

| Depth | C.E.C.[1] | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | Weight loss on ignition | $\frac{SiO_2}{R_2O_3}$ |
|---|---|---|---|---|---|---|---|
| Inches | Meq./ 100 g. | Percent | Percent | Percent | Percent | Percent | |
| 0-4 | -- | 43.9 | 17.6 | 7.3 | 2.5 | 16.2 | 3.36 |
| 4-7 | 77.2 | 42.0 | 21.4 | 7.6 | -- | 12.5 | 2.72 |
| 7-10 | 76.0 | 45.0 | 19.4 | 7.6 | -- | 14.3 | 3.16 |
| 10-12 | 75.5 | 45.9 | 19.2 | 8.3 | 4.2 | 14.4 | 3.18 |
| 12-18 | 67.8 | 45.1 | 20.5 | 7.7 | 5.2 | 15.6 | 3.02 |
| 18-25 | -- | 44.9 | 20.3 | 8.7 | 4.8 | 14.3 | 2.96 |
| 25-32 | 74.7 | 45.4 | 22.0 | 9.8 | 6.6 | 13.0 | 2.74 |
| 32-42 | 72.7 | 50.2 | 21.9 | 8.3 | .3 | 13.1 | 3.14 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 80-84 | 75.1 | 48.1 | 20.4 | 10.1 | .3 | 10.7 | 3.05 |

NATIVE GRASS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0-6 | -- | 44.7 | 16.1 | 7.1 | 5.3 | 16.6 | 3.69 |
| 6-12 | 72.2 | 40.6 | 16.3 | 8.0 | 4.3 | 17.2 | 3.22 |
| 12-18 | 81.2 | 44.5 | 17.9 | 8.5 | 5.9 | 17.6 | 3.25 |
| 18-27 | 84.5 | 41.8 | 17.1 | 6.9 | 5.6 | 17.6 | 3.32 |
| 27-40 | 85.1 | 26.2 | 10.6 | 9.8 | 15.8 | 13.2 | 2.64 |
| 40-48 | 56.2 | 21.4 | 9.5 | 6.4 | 23.9 | 15.5 | 2.68 |
| -- | -- | -- | -- | -- | -- | -- | -- |
| 77-80 | -- | 10.4 | 4.7 | 3.5 | 33.0 | 10.0 | 2.54 |

[1] Na acetate method on $< 0.2\,\mu$ clay with carbonates and organic matter removed; other analyses on $< 2\,\mu$ clay.

Table 39.--Clay minerals[1] present in Pratt fine sandy loam.

| Cultivated | | | Native grass | | |
|---|---|---|---|---|---|
| Depth | Minerals | | Depth | Minerals | |
| Inches | <0.2μ | 0.2-2μ | Inches | <0.2μ | 0.2-2μ |
| 0-4 | MI/K | IK/MV | 0-6 | MI/K | IK/MV |
| 4-7 | MI/K | IK/MV | 6-12 | MI/K | IK/MV |
| 7-10 | MI/K | IK/MV | 12-18 | MI/K | IK/MV |
| 10-12 | MI/K | IK/MV | 18-27 | MI/K | IK M/V |
| 12-18 | M/IK | IK/MV | 27-40 | MI/K | IK M/V |
| 18-25 | M/IK | IKM | 40-48 | M/I | IKM |
| 25-32 | M/IK | IKM | -- | -- | -- |
| 32-44 | MI/K | IKM | 77-80 | M | MKI |
| -- | -- | -- | | | |
| 80-84 | M | IMK | | | |

[1] I = illite, K = kaolinite, M = montmorillonite, V = vermiculite. The most abundant minerals, for both dominant and minor amounts, are indicated first in the sequences. Minor amounts present are indicated after the diagonal; e.g., MI/K is montmorillonite and illite dominant mineral with a minor amount of kaolinite.

## Grant Silt Loam[5]

Grant silt loam soil occupies gently sloping uplands in northwest central Oklahoma and south-central Kansas. It is a deep, moderately dark Reddish Prairie soil developed in reddish silty or loamy earths usually underlain by silty and sandy redbeds of the Permian. It is a very fertile and productive soil. Nearly all of it is in cultivation, largely to winter wheat.

This soil has a neutral to slightly acid brown surface and a reddish-brown friable subsoil.

### Grant Silt Loam (native grass)

Location: Seven hundred and thirty-five feet east and 840 feet north of the southwest corner of NW1/4, Section 22, T. 26 N., R. 11 W., Alfalfa County, Okla., on the E. D. Smith farm.

[5] Profile descriptions written by Bill Swafford and Fred J. Dries, Soil Scientists, SCS, Enid, Okla.

A1 0 to 10 inches, brown (7.5YR 5/4) silt loam; dark brown (7.5YR 4/4) when moist; weak, granular structure; hard when dry, friable when moist; roots abundant; noncalcareous; gradual boundary.

A3 10 to 22 inches, reddish-brown (5YR 4/4) silt loam; dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; hard when dry, friable when moist; roots and wormcasts abundant; noncalcareous; gradual boundary.

B2t 22 to 48 inches, yellowish-red (5YR 5/8) loam; yellowish red (5YR 4/8) when moist; moderate, medium, subangular blocky and granular structure; friable when moist; roots abundant; some water-worn gravel; noncalcareous; gradual boundary.

Cca 48 to 54 inches, yellowish-red (5YR 4/6) silt loam; weak, granular structure; hard when dry, friable when moist; calcareous, with many films, threads, and soft masses of $CaCO_3$; gradual boundary.

C 54 to 72 inches, yellowish-red (5YR 4/6) silt loam; weak, granular structure; friable when moist; very few films and threads of $CaCO_3$; grades to gravel bed.

IIC 72+ inches, sand and gravel bed.

## Grant Silt Loam (cultivated)

Location: Eight hundred eighty feet east and 480 feet north of the southwest corner of NE1/4, Section 16; T. 26 N., R. 11 W., Alfalfa County, Okla., on the Wheatland Conservation Experiment Station.

Ap 0 to 6 inches, brown (10YR 5/3) silt loam; dark brown (10YR 3/3) when moist; weak, granular structure; hard when dry, friable when moist; roots abundant; noncalcareous; abrupt boundary.

A1 6 to 8 inches, brown (10YR 5/3) silt loam; dark brown (10YR 3/3) when moist; weak, granular structure; compact and very hard when dry; very few pores; noncalcareous; clear boundary.

A3 8 to 20 inches, reddish-brown (5YR 4/3) loam; dark reddish brown (5YR 3/3) when moist; moderate, fine, subangular blocky and granular structure; hard when dry, friable when moist; many wormcasts; noncalcareous; contains a few very small pebbles; gradual boundary.

B2t 20 to 46 inches, yellowish-red (5YR 4/6) loam; moderate medium granular and subangular blocky structure; hard when dry, friable when moist; noncalcareous; gradual boundary.

B3 46 to 72 inches, red (2.5YR 4/6) silt loam; weak, subangular blocky structure; friable when moist; weakly calcareous; contains a few small pebbles; diffuse boundary.

C 72+ inches, red (2.5YR 4/6) loamy fine sand; very friable when moist; contains a few small $CaCO_3$ concretions; weakly calcareous.

Table 40.--Mechanical analyses of Grant silt loam.

CULTIVATED

| Depth | Sand | Silt | Clay | Textural class |
|---|---|---|---|---|
| Inches | Percent | Percent | Percent | |
| 0-6 | 36.8 | 50.2 | 13.0 | Silt loam. |
| 6-8 | 33.3 | 50.2 | 16.5 | Do. |
| 8-20 | 37.4 | 46.0 | 16.6 | Loam. |
| 20-46 | 40.0 | 35.8 | 24.2 | Do. |
| 46-72 | 47.2 | 49.3 | 3.5 | Silt loam. |
| 72-76 | 78.5 | 19.3 | 2.2 | Loamy sand. |
| NATIVE GRASS | | | | |
| 0-10 | 25.1 | 65.4 | 9.5 | Silt loam. |
| 10-22 | 26.9 | 61.1 | 12.0 | Do. |
| 22-48 | 50.3 | 36.8 | 12.9 | Loam. |
| 48-54 | 45.7 | 51.4 | 2.9 | Silt loam. |
| 54-68 | 32.1 | 66.3 | 1.6 | Do. |

Table 41.--Soil-moisture relationships for Grant silt loam.

CULTIVATED

| Depth | Soil-moisture tension for-- | | | | Bulk density |
|---|---|---|---|---|---|
| | 1/3 bar | 1 bar | 5 bars | 15 bars | |
| Inches | ---------Percent moisture by weight--------- | | | | G./cc. |
| 0-6 | 17.4 | 9.4 | 6.6 | 5.3 | 1.51 |
| 6-8 | 22.1 | 13.2 | 9.0 | 7.4 | 1.37 |
| 8-20 | 20.8 | 12.8 | 9.2 | 7.5 | 1.28 |
| 20-46 | 23.2 | 15.7 | 11.8 | 9.6 | 1.40 |
| 46-72 | 19.7 | 12.8 | 9.4 | 7.5 | 1.52 |
| 72-76 | 10.6 | 7.0 | 5.1 | 3.9 | -- |
| NATIVE GRASS | | | | | |
| 0-10 | 16.8 | 8.9 | 6.1 | 4.8 | 1.33 |
| 10-22 | 14.4 | 8.6 | 6.4 | 5.2 | 1.20 |
| 22-48 | 14.9 | 9.1 | 7.0 | 5.6 | 1.47 |
| 48-54 | 24.9 | 16.8 | 11.5 | 8.6 | 1.57 |
| 54-72 | 14.5 | 7.4 | 4.6 | 3.8 | 1.69 |
| 72-75 | 8.1 | -- | 2.5 | 2.1 | -- |

Table 42.--Atterberg limits for Grant silt loam.

| Horizon | Liquid limit | Plastic limit | Plasticity index[1] |
|---|---|---|---|
| | | CULTIVATED | |
| Inches | Percent | Percent | |
| 0-6 | 21.2 | 19.2 | 2.0 |
| 6-8 | 23.4 | 19.9 | 3.5 |
| 8-20 | 24.6 | 18.7 | 5.9 |
| 20-32 | 23.1 | 17.0 | 6.1 |
| 32-46 | 24.1 | 15.8 | 8.3 |
| 46-56 | 24.3 | 17.0 | 7.3 |
| 56-72 | 23.2 | 16.8 | 6.4 |
| | | NATIVE GRASS | |
| 0-10 | 24.0 | 18.5 | 5.5 |
| 10-16 | 22.6 | 17.8 | 4.8 |
| 16-22 | 23.3 | 16.8 | 6.5 |
| 22-32 | 21.1 | 12.9 | 8.2 |
| 32-48 | 23.5 | 16.6 | 6.9 |
| 48-54 | 20.5 | 15.8 | 4.7 |
| 54-72 | 21.6 | 19.0 | 2.6 |

[1] See footnote, table 3.

Table 43.--Chemical data for Grant silt loam.

CULTIVATED

| Depth | Extractable ions | | | | C.E.C. | pH | O.M. | $CaCO_3$ equiv. | Free $Fe_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|
| | Na | K | Ca | Mg | | | | | |
| Inches | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | Meq./ 100 g. | | Per- cent | Per- cent | Per- cent |
| 0-6 | 0.07 | 0.56 | 3.0 | 1.8 | 10.9 | 5.7 | 1.16 | -- | 0.30 |
| 6-8 | .04 | .36 | 3.0 | 2.9 | 15.9 | 5.6 | 1.16 | -- | .15 |
| 8-20 | .08 | .33 | 6.3 | 2.5 | 12.0 | 6.1 | .98 | -- | .14 |
| 20-46 | .12 | .30 | 6.6 | 3.3 | 13.9 | 6.4 | .66 | -- | .21 |
| 46-72 | .17 | .21 | 9.0 | 4.3 | 10.4 | 7.3 | .25 | 2.2 | .25 |
| 72-76 | .14 | .13 | 4.4 | 3.2 | 8.3 | 7.4 | .09 | 1.8 | .21 |
| NATIVE GRASS | | | | | | | | | |
| 0-10 | 0.09 | 0.63 | 4.0 | 1.5 | 12.1 | 5.5 | 1.83 | -- | 0.24 |
| 10-22 | .10 | .30 | 6.3 | 2.2 | 13.0 | 5.6 | .88 | -- | .18 |
| 22-48 | .09 | .23 | 4.4 | 2.9 | 13.0 | 6.0 | .66 | -- | .28 |
| 48-54 | .10 | .08 | 6.0 | 3.2 | 9.8 | 7.5 | .32 | 8.9 | .27 |
| 54-72 | .08 | .08 | 5.0 | 1.8 | 9.4 | 6.4 | .09 | .6 | .26 |
| 72-75 | .08 | .07 | 4.9 | .5 | 4.4 | 7.4 | .19 | 4.7 | .19 |

Table 44.--Chemical analyses of the clay fraction from Grant silt loam.

CULTIVATED

| Depth | C.E.C.[1] | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | Weight loss on ignition | $\frac{SiO_2}{R_2O_3}$ |
|---|---|---|---|---|---|---|---|
| Inches | Meq./ 100 g. | Per-cent | Per-cent | Per-cent | Per-cent | Per-cent | |
| 0-6 | 73.6 | 30.0 | 14.3 | 7.9 | 9.2 | 13.3 | 2.63 |
| 6-8 | 84.9 | 33.4 | 16.7 | 6.7 | 19.1 | 10.5 | 2.70 |
| 8-20 | 90.5 | 38.7 | 16.7 | 7.2 | 10.7 | 11.3 | 3.08 |
| 20-46 | 72.9 | 38.5 | 19.6 | 7.3 | 9.8 | 10.2 | 2.69 |
| 46-72 | 88.9 | 33.6 | 16.2 | 4.8 | 13.7 | 10.1 | 2.96 |
| 72-76 | 84.9 | 29.7 | 12.1 | 9.3 | 18.9 | 8.3 | 2.79 |
| NATIVE GRASS | | | | | | | |
| 0-10 | 77.3 | 27.2 | 10.3 | 2.8 | 18.9 | 11.2 | 3.82 |
| 10-22 | 72.6 | 30.0 | 16.3 | 6.9 | 15.8 | 10.4 | 2.46 |
| 22-48 | 84.5 | 32.5 | 14.5 | 3.1 | 15.8 | 9.9 | 3.35 |
| 48-54 | 87.6 | 35.2 | 16.2 | 6.7 | 13.0 | 9.0 | 2.92 |
| 54-72 | 83.7 | 27.0 | 10.1 | 2.6 | 18.1 | 8.7 | 3.92 |
| 72-75 | 84.2 | 18.1 | 5.7 | 3.1 | 23.6 | 8.5 | 4.00 |

[1] Na acetate method on $< 0.2\,\mu$ clay with carbonates and organic matter removed; other analyses on $< 2\,\mu$ clay.

Table 45.--Clay minerals[1] present in Grant silt loam.

| Cultivated | | | Native grass | | |
|---|---|---|---|---|---|
| Depth | Minerals | | Depth | Minerals | |
| Inches | <0.2μ | 0.2-2μ | Inches | <0.2μ | 0.2-2μ |
| 0-6 | IM | IK/M | 0-10 | MI/K | IKM |
| 6-8 | IM | IK/M | 10-22 | MI | IKM |
| 8-20 | IM | IK/M | 22-48 | M/I | IKM |
| 20-46 | IM | IKM (W) | 48-54 | M/I | IKM (W) |
| 46-72 | IM | IKM (M) | 54-72 | M/I | IKM (W) |
| 72-76 | M/I | IKM (M) | 72-75 | M/I | IKM |

[1] I = illite, K = kaolinite, M = montmorillonite. The most abundant minerals, for both dominant and minor amounts, are indicated first in the sequences. Minor amounts present are indicated after the diagonal; e.g., M/I is montmorillonite dominant mineral with a minor amount of illite.

Relative intensity of 12.3 Å (when present) is shown in parentheses, as follows:

M = moderate--less intense than other peaks;
W = weak--less than 10% of full-scale deflection above background.

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